

FLIGHT

The
AIRCRAFT ENGINEER
AND AIRSHIPS

First Aeronautical Weekly in the World. Founded January, 1909

Founder and Editor: STANLEY SPOONER

A Journal devoted to the Interests, Practice and Progress of Aerial Locomotion and Transport

OFFICIAL ORGAN OF THE ROYAL AERO CLUB OF THE UNITED KINGDOM

No. 1170. (Vol. XXIII. No. 22.)

MAY 29, 1931

Weekly, Price 6d.
Post free, 7½d. Abroad, 8d.

Editorial Offices: 36, GREAT QUEEN STREET, KINGSWAY, W.C.2.

Telephone: (2 lines), Holborn 3211 and 1884.

Telegrams: Truditur, Westcent, London.

Annual Subscription Rates, Post Free.

United Kingdom .. 33s. 0d. United States .. \$8.75.

Other Countries .. 35s. 0d.*

* Foreign subscriptions must be remitted in British currency. (See last Editorial Page.)

CONTENTS

| | PAGE |
|---|------|
| Editorial Comment: | |
| The Needs of Bombay | 467 |
| Specialisation | 468 |
| Catapulting a "Virginia" | 469 |
| Tour of France | 471 |
| Stockholm Aero Exhibition | 473 |
| Air Transport | 476 |
| Airport News | 478 |
| THE AIRCRAFT ENGINEER | 478a |
| Private Flying and Club News | 479 |
| The Metal-Clad Airship. By C. B. Fritsche | 483 |
| Airisms from the Four Winds | 487 |
| Royal Air Force | 489 |
| In Parliament | 489 |
| Aircraft Companies' Stocks and Shares | 490 |

EDITORIAL COMMENT



INDIA was the first country in the British Empire, if not in the world, to establish a regular official air mail. That happened in 1919. The service connected Bombay with Delhi, if we remember right, and the aeroplanes used were military D.H. 10 twin-engined bombers. The schedule was

very badly drawn up; as a public service it was of very little use to anybody; the costs per ton-mile were appalling, and the experiment was speedily abandoned. India, in fact, had been rash. For once she had endeavoured to lead the world in up-to-dateness, and she had signally failed. The more usual and typical course is for India to follow some years behind the rest of what is called the civilised world. It was a fool, wrote Kipling, who tried to hustle the East.

Repenting of her rashness and of her solitary experiment in leading the world, India has since given ample evidence of her repentance, and of her determination to lag behind where civil flying is concerned. For years we have been told that the Government of India was preparing the air route from Karachi to Calcutta and on to Rangoon. What she has actually accomplished so far is an air service between Karachi and Delhi. We still wait hopefully for the extension on to Calcutta. The Calcutta-Rangoon section has been abandoned with a sigh of relief which could almost be heard across the Gulf of Arabia, the Red Sea, and the Mediterranean. That section must be left for the prospective Government of Burma when the schism is brought about. A fleet of Avro 10 machines has been ordered for the Calcutta-Delhi section, and we are assured that when they are delivered that section really will be opened. We must wait, and perhaps we shall see.

Certainly the prime necessity of air transport in India is a link between Karachi and Calcutta. But, while Calcutta is the most important commercial city in India, as well as lying on the route which leads to Australia, Bombay comes a very good second in

DIARY OF CURRENT AND FORTHCOMING EVENTS

Club Secretaries and others desirous of announcing the dates of important fixtures are invited to send particulars for inclusion in this list:—

- 1931
- May 28-June 13. Royal Tournament at Olympia.
 - May 30. Air Union Reception of Capt. Costes, Croydon.
 - May 30. Heston-Newcastle Air Race.
 - May 31. N.F.S. Air Pageant, Sherburn-in-Elmet, Yorks.
 - June 2. R.A.F. Middle East Dinner at Connaught Rooms.
 - June 3. Reception to I.C.A.N. at Park Lane Hotel.
 - June 5-6. Scottish Flying Club Air Display, Glasgow.
 - June 6. Brooklands Air Display.
 - June 6. Lincolnshire Ae.C. Meeting at Cleethorpes.
 - June 6-12. F.A.I. Conference, Bucharest.
 - June 7. N.F.S. Air Pageant, Hull.
 - June 8. International Rally, Bucharest.
 - June 9. Air League "Speed" Ball at the Dorchester Hotel.
 - June 13. May Week Meeting, Marshall's School, Cambridge.
 - June 13-14. Leicestershire Ae.C. "At Home" at Desford.
 - June 18. R.A.F. Flying Display and Polo Gymkhana at Halton.
 - June 20. Flying Display, Bristol Airport S.B.A.C. Cup Race.
 - June 21. N.F.S. Air Pageant, Reading.
 - June 22. Entries Close for King's Cup Race.
 - June 26. R.A.F. Dinner Club Annual Dinner, Connaught Rooms.
 - June 27. Royal Air Force Display, Hendon.
 - July 10-19. Circuit of Italy.
 - July 22. Household Brigade Flying Club Meeting, Heston.
 - July 25. King's Cup Race.
 - July 25-Aug. 9. Rhon Gliding Competitions, Germany.
 - Aug. 15. Manchester-Liverpool Inter-City Race.
 - Aug. 22. Newcastle-on-Tyne Meeting.
 - Aug. 29. Norfolk and Norwich Club Meeting at Yarmouth.
 - Sept. 5. Haldon Flying Meeting.
 - Sept. 12. Schneider Trophy Contest.

commercial importance. In air-mindedness, the commercial interests in Bombay seem considerably superior to the corresponding interests in Calcutta. The very influential Calcutta Chamber of Commerce has not shown any white-hot desire to influence the Government of India to hurry on the coming of the air mail. Bombay, on the contrary, has been seething with indignation at the thought that Calcutta was to get air mail services before they were supplied to *Urbs Prima in Indis*. Not only has Calcutta long been a rival to Bombay; Karachi is also an old rival which Bombay has affected to despise, but has really feared. So far as air mails are concerned, Karachi has now short-circuited Bombay. If aircraft are to be the regular mail carriers of the future, Bombay sees herself deprived of her historic importance as the mail port of India. That she should be supplanted by Karachi, the "Tradesman's Entrance," as Bombay has called the northern port, is a pill without any gilding, and bitter to swallow.

Hence there has arisen in Bombay a very healthy outcry that her air mails must be sent on from Karachi by aircraft, and not left to the tender mercies of the somewhat leisurely Indian railways. She has been accustomed to receiving her mails earlier than any other city in India, by virtue of being the port of arrival for the mail steamers. That she should actually receive them later than Calcutta receives hers, as seems a possibility of the near future, is an intolerable thought to the proud western capital.

This outcry on the part of Bombay got as far as the House of Commons on May 11, when the Secretary of State for India was asked a question on the subject. Mr. Wedgwood Benn replied that the Government of India hoped that it would be possible to provide an air mail service for Bombay at a date not long after the inauguration of the Karachi-Calcutta sector. The extortion of this statement, hedged round though it is by provisos, is satisfactory so far as it goes. It is a good thing to keep on urging the Indian Government to get busy, and not to let it think that when at long last it actually starts the air service between Delhi and Calcutta it has done all that can reasonably be expected of it. The claims of Bombay ought not to be disregarded. When they are in a fair way to be satisfied, it will not be too soon for Madras, the third most important commercial city in India, to begin to urge her claims to consideration. Madras is far from the steamship port of Bombay, and farther still from the air port of Karachi. Her mails badly need speeding up. But Calcutta obviously must come first, and Bombay second. We trust that air services to those two important cities will not be very much longer delayed.

❖ ❖ ❖

During the past week an interesting experiment has been made at Aldershot, namely, the organisation of a complete wing of army co-operation squadrons and its employment in conjunction with a large military force. The latter consisted of a corps of two divisions, corps troops, and a cavalry division. Of recent years it has been customary to allot one

R.A.F. squadron (of course, one of the army co-operation squadrons) to work with one division of the army. The mobilisation of a wing is somewhat of an unusual occurrence since the war. Wing commanders there are in plenty, but wings are rare phenomena. In this case it does not seem that the wing was fully organised. Nos. 4, 13 and 16 A.C. Squadrons were united to form the wing, but there seems to have been no special provision of other units such as would be necessary if a wing were to take the field for a prolonged period. Stores were probably drawn according to some temporary arrangement, and doubtless it was not thought worth while to establish a repair section for a wing which was to have an active existence of only a few days. The three squadrons come from aerodromes somewhat widely scattered, No. 4 from South Farnborough, No. 13 from Netheravon and No. 16 from Old Sarum. For the purposes of peace and of manœuvres it is probably most convenient to consider the squadron or a station as a unit; but in war, wings and even larger commands will have to be organised and to be made self-contained as regards equipment and repairs.

The lessons gained by this temporary mobilisation of a wing were doubtless valuable, especially on the tactical side. What chiefly strikes us, however, are some comments made by a military correspondent of *The Times* in reporting the operations. Alluding to the ordinary relations of one squadron with one division, he wrote: "The officers of both services have become intimately acquainted, and everyone with war experience knows the extent to which such acquaintanceships make for co-operation when on service." Afterwards, when considering the corps *cum* wing operations, he wrote: "I was struck by the zeal of the pilots and also by the extent to which their work necessitates military knowledge, which can only be learned by experience." We have ourselves been impressed on more than one occasion by the necessity for the pilot of an army co-operation squadron to consider everything which he sees with an army mind. These officers must be specialists. Their work as specialists is extremely interesting, and there can be no doubt that the pilots engaged on it become most enthusiastic about it. The sensible conclusion seems to be that they ought to give the whole of their service life to this specialised work, and should not be transferred to another branch of air work.

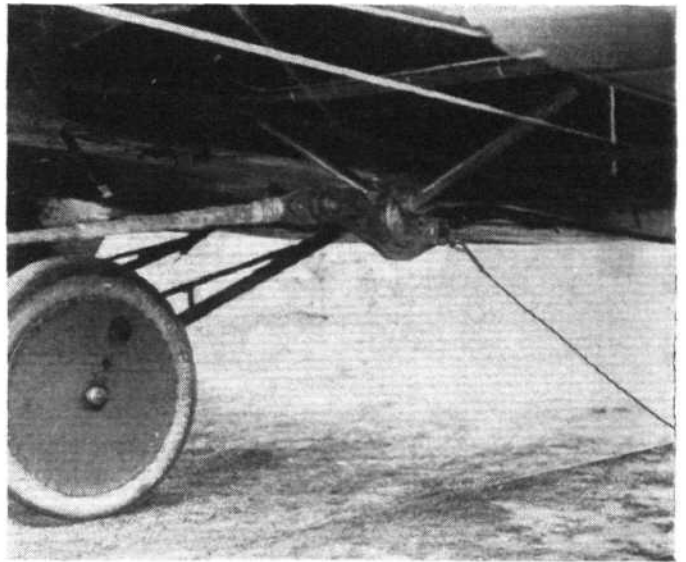
The same can be said of pilots who have to specialise in ship-plane work and flying-boat work. Their minds need to be more than half naval. Yet it does sometimes happen that when a pilot has become highly proficient in one of these specialised branches he is transferred by the Air Ministry to a squadron which has to carry out a totally different class of work. The specialised knowledge which he has acquired is then largely wasted. Probably the excuse which the Air Ministry would make is that it wants as many pilots as possible to be proficient in as many branches of air work as possible. If so, the plea would not be very convincing. We all know the saying about Jacks of all trades.



CATAPULTING A "VIRGINIA"

THE catapult is now a recognised adjunct of the ship-plane, and a few months ago we published an illustration of a Fairey 3 F being launched from a ship-type catapult which was anchored on the ground at South Farnborough. The principle of this apparatus was that the machine was mounted on a carriage which was shot forward against a stop. This works well for machines of comparatively light weight which can be hoisted without much difficulty on to the carriage. It would be of no use for heavy night bombers. The Royal Air Force, however, is of opinion that it would be a good thing to be able to propel a night bomber into the air with a very short run. The first thing was to prove that it was possible to do it. The next step should be to make the apparatus portable, so that it could be sent on to country where there was not enough level space to allow a "Virginia" to take off (normally this machine needs a run of some 300 yards), but which was considered for other reasons a suitable base for night bomber aeroplanes. The first of these two stages has now been reached, and on Thursday, May 21, the Press were invited to South Farnborough to see a demonstration of launching a "Virginia" with a run of some 33 yards.

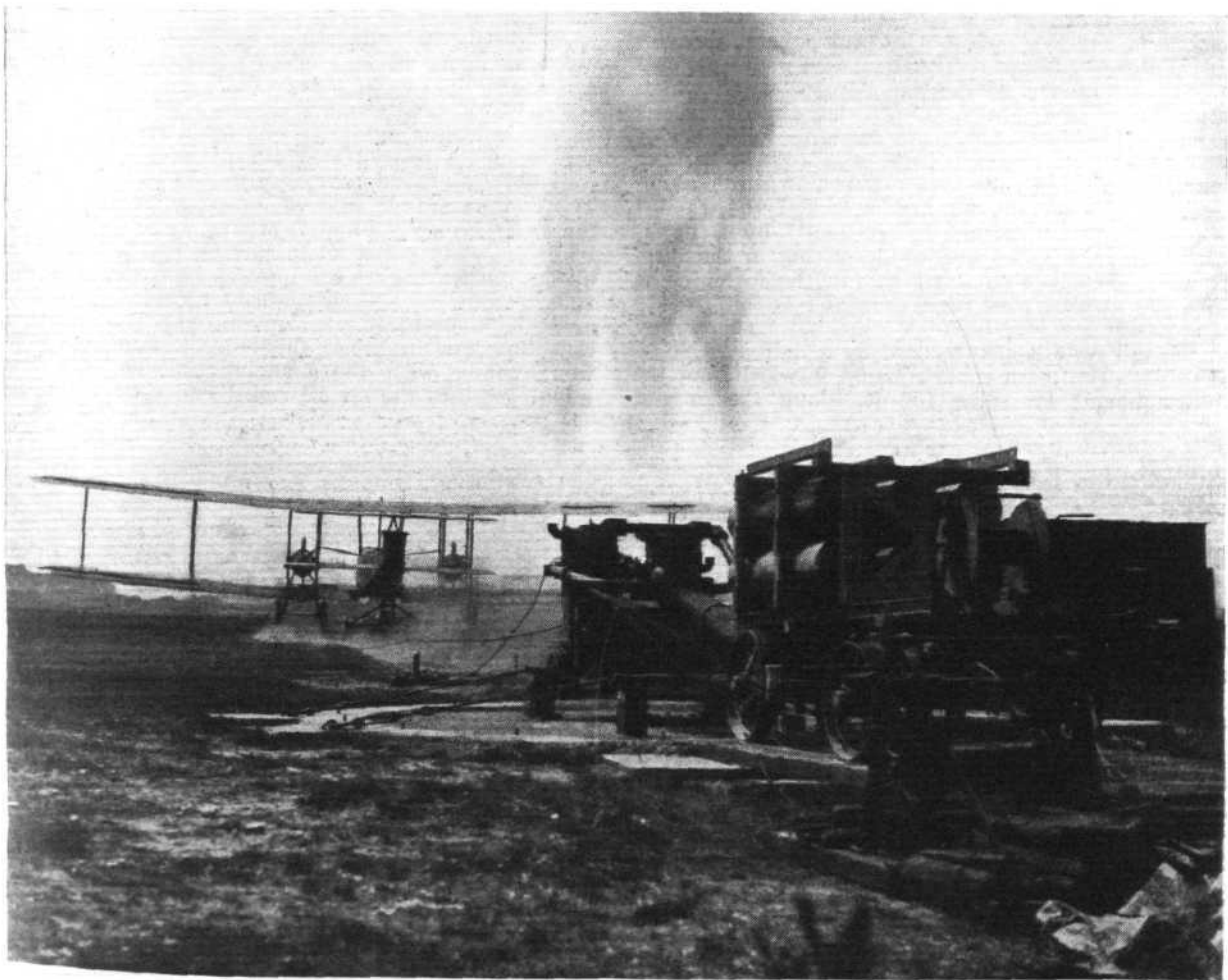
Fickle May was graciously pleased to permit a fine sunny day for the demonstration, but a wind of about 15 m.p.h. was blowing across the runway. This brought home to the spectators the handicap of having fixed anchorages. These at present consist of very heavy concrete blocks let into the ground at each end of the run-



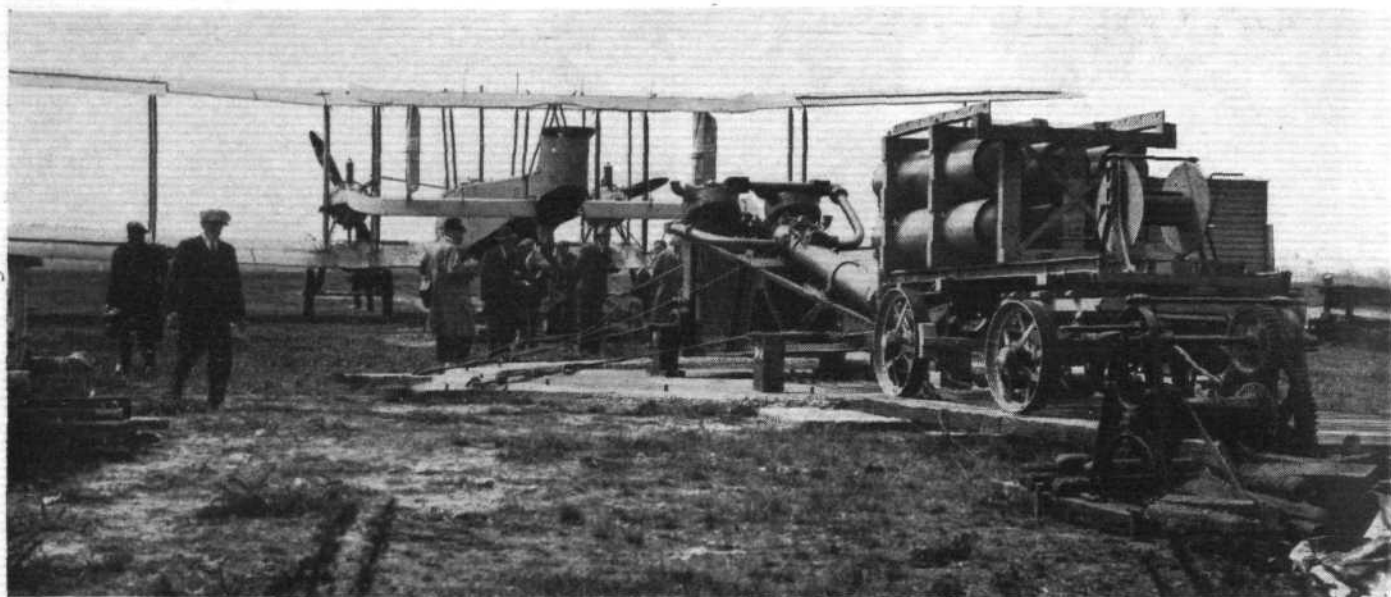
This photograph shows the point at which the cable is attached by a hook to the fuselage. (FLIGHT Photo.)

way, and naturally they cannot be shifted to permit a run into the wind. When we arrived on the aerodrome the "Virginia" was standing on the runway, resting on its own wheels, but with its tail raised into flying position and resting on a cumbrous-looking wheeled trolley. The details of the apparatus are still rudimentary, and have a very rough-and-ready appearance. That does not matter, however, for the present. The first thing is to prove the feasibility of launching the heavy bomber. The design of the equipment can be elaborated afterwards.

The word "catapult" is convenient, but gives a false



The compressed air engines are at work. A cloud of steam rises overhead. The "Virginia" has already lifted off the ground, slightly right wing down owing to the side wind. The tail is clear of the trolley, which has stopped running. We rejoice that we cannot reproduce the noise of the engines. (FLIGHT Photo.)



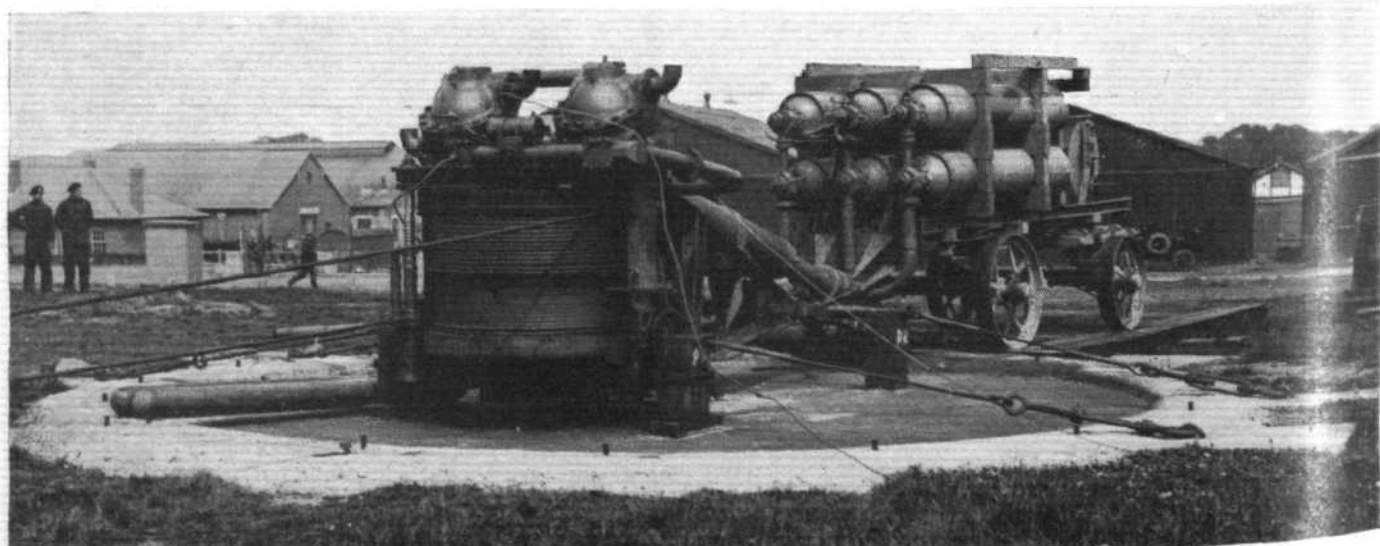
The "Virginia" and engines before the start. (FLIGHT Photo.)

impression of the mechanical principles of this device. The word was first used by the Romans for a piece of siege ordnance which hurled missiles against a fortified post, on the principle of getting up impetus by allowing a weight to drop against a stop, which checked the carrier arm but permitted the missile to fly freely on. The ship-plane catapult also brought the carrier up against a stop. The catapult of the schoolboy, worked by stretching elastic, is familiar to everyone. The R.A.E. catapult operates by revolving a cable round a drum and so pulling the aeroplane forward at about 60 m.p.h. for 100 ft. in three seconds. The motive power is provided by two combined compressed air engines, which between them develop 4,000 h.p. These engines are very small and compact, and they are mounted on top of the large drums round which the ends of the cable are secured. Behind the drums, as can be seen in the illustrations, are six large cylinders of compressed air, which develop a pressure of 400 lb. per square inch. The cable runs forward from a drum along the ground, and is caught up and attached to a point underneath the fuselage of the "Virginia" by a hook. This hook is temporarily secured to the fitting in the fuselage, but when the machine starts to run the fastening is released by the ground staff, and the hook is left free to fall so soon as the machine outruns the cable. The trolley on which the tail rests is also secured by a lighter cable to the main cable. The main cable runs on forward from the point of attachment for some 100 ft. along the ground-

to a pulley anchored to a block of concrete. The anchorage is flush with the ground, and the pulley is below the ground level and is covered over with timber. There must be a considerable amount of friction where the cable is in contact with the ground, and especially where it is carried below ground level. From the pulley the cable returns to the drums under the engine. Incidentally, the engines and the air cylinders are mobile, but the engines and drum are secured to another concrete block. The problem which lies before the Farnborough experts is to find a movable pair of anchorages. Without these, it does not seem that the catapult serves any very obviously useful purpose, though it is distinctly interesting to know that an aeroplane weighing up to 10 tons can be launched into the air after a run of only 100 ft.

The "Virginia," which provided the *corpus vile* for this experiment, was naturally not fully loaded. As she stood she weighed about 8 tons. To this had to be added the weight of the trolley, which also had to be moved forward. The compressed-air engines, however, received the help of the two Napier "Lions," which were started before the launching device was set in motion, and which were opened up to full throttle by the pilot as he gave the signal to go.

Two pilots took their seats in the cockpit, and, as they arranged their parachutes on the seats, one could not help reflecting how little use these things would be if anything went wrong with the launching. Still, of course, they might get into the air all right, and then a parachute was

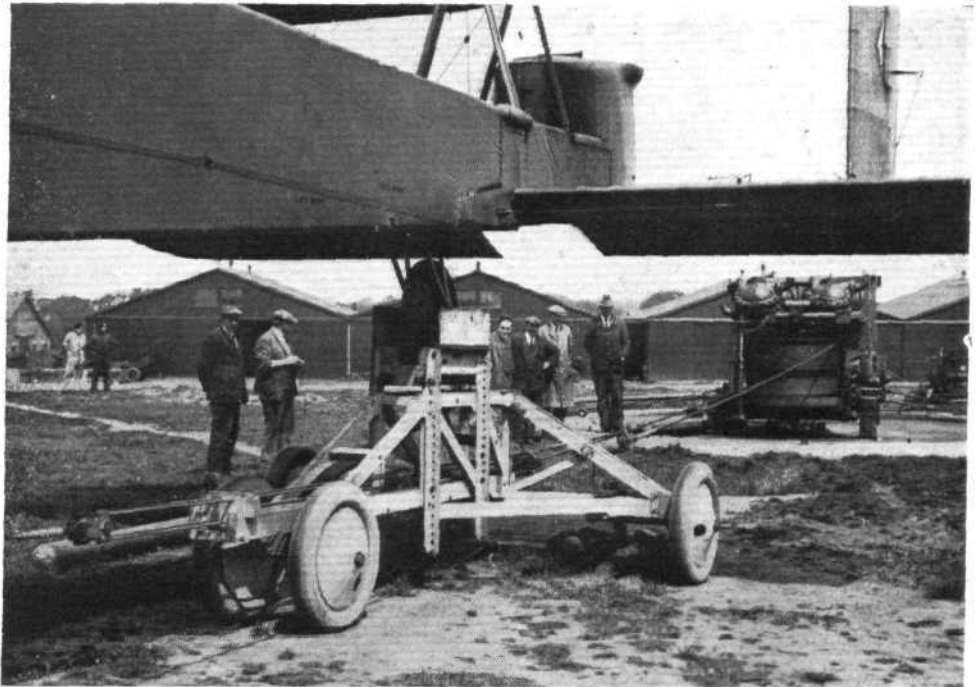


The twin compressed-air engines which together develop 4,000 horse power. The cylinders of compressed air are behind them. (FLIGHT Photo.)

a handy thing to have about, especially as the air was fairly full of aircraft, most of which were concerned with some experiment or other. Squadron-Leader W. S. Caster, M.C., took charge of the controls. By his side sat Flight-Lieut. J. A. T. Ryde, who will pilot the "Virginia" in a similar demonstration at the R.A.F. Display on June 27. They both looked remarkably unperturbed as they took their seats. Squadron-Leader Caster said that the first few times that he had been shot off he felt curious sensations, something like when a lift starts suddenly to go down. It gave the sensation of leaving one's interior mechanism behind. But they soon found out that the thing to do was to start with the body and head braced hard back against the seat, and then there was no unpleasant sensation worth mentioning. If the body were slack when the acceleration began, one might get a sudden push in the back, and the neck might be jerked.

The "Lion" engines were run up. They gave some appearance of life to the bulk of the "Virginia," but the thing looked extremely impassive. With its tail on that awkward-looking trolley, it seemed intended to stay put till the cows came home. Through one's mind ran some thoughts of the old problem of what would happen if something irresistible met something immovable. The squadron leader raised his hand. The ground staff round the engines did something; and then things began to happen so fast that one could not take them all in. The outstanding phenomenon was a scream from the engines "as though men fought upon the earth and fiends in upper air." The drums of one's ears wilted and curled up, and what happened to microphones which were close by one trembles to think.

From the engines arose a cloud of white steam. When one collected one's senses enough to look at the "Virginia," the effect was equally astounding. The dignified monster was careering away down the runway somewhat like an elephant on an Earl's Court waterchute. The startled eyes could scarcely appreciate the speed. Then there was a shock, as the tail trolley stopped dead and the tail lifted clear from it. Already the wings were lifting, and the great night bomber was air-borne. One wing of the machine was rather down, owing to the side wind, but, before the cable stopped hauling, the wheels were clear of the ground. The "Virginia" flew serenely away.



The wheeled trolley on which the tail of the machine is supported in flying position.

(Flight Photo.)

THE TOUR OF FRANCE

AS announced last week, the results of the "Take-off" and "Landing" Competitions in connection with the Tour of France, which concluded at Orly on May 10, were not received in time for inclusion in our last report. We now give these in the accompanying table, from which it will be seen that the winner was M. Vercruysse, on a Mauboussin monoplane, fitted with a 40-h.p. Salmson engine. Here we would point out an error that appeared in the table published last week—and we might add that the error originated from the official lists. Vercruysse was shown as piloting a Potez 36, whereas his machine was actually the Mauboussin.

These competitions were held at the Orly and Buc

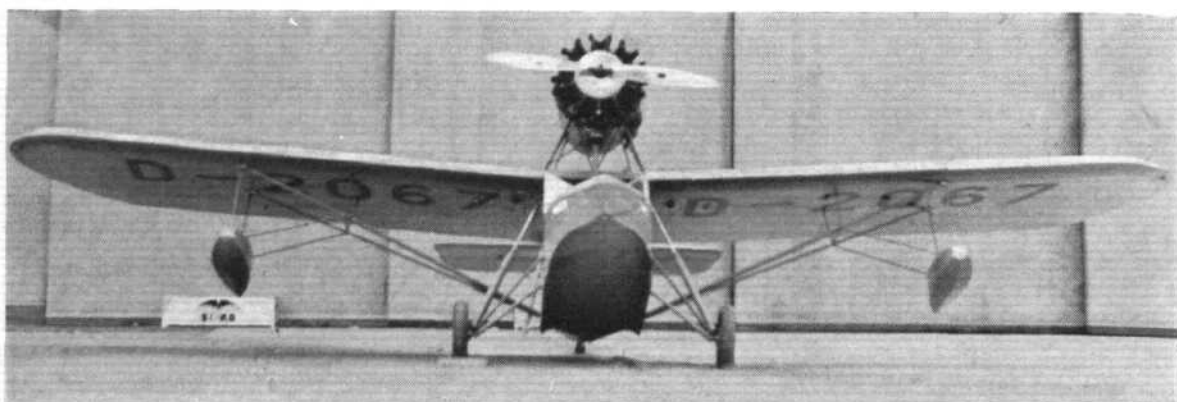
Airports shortly after the finish of the Tour of France. For the "Take-off" Competition, machines had to fly over an outstretched cord, held at a height of one metre, at a distance chosen by the contestants. For the "Landing" Competition, machines had to pass over the same cord on landing, the distance being measured from the cord to the axis of the wheels where the machine had come to rest.

Each "take-off" and "landing" had to be effected on approaching the cord at a right angle, and the machines were not allowed to go outside a "lane" 40 m. (131 ft.) wide, previously marked out.

Only 20 of the Tour of France competitors took part in these competitions.

TOUR OF FRANCE: "TAKE OFF" AND "LANDING" COMPETITIONS

| Pilot. | Machine. | Engine and horse-power. | "Take off," min. | "Landing," min. | Additional Premium, per cent. | No. of Points. |
|-----------------|--------------------|-------------------------|------------------|-----------------|-------------------------------|----------------|
| Vercruysse | Mauboussin .. | 40 Salmson .. | 50 | 25 | 10 | 426.60 |
| Ripault .. | Potez 36 .. | 95 Renault .. | 95 | 31 | 10 | 781.33 |
| Roulin .. | Caudron 232 .. | 95 Renault .. | 92 | 50 | 10 | 880.55 |
| Le Folcavez | Moth D.H. 60 .. | 85 Gipsy .. | 80 | 72 | 10 | 890.70 |
| Labouchere | Potez 36 .. | 95 Salmson .. | 82 | 62 | 10 | 892.95 |
| Nicolesco .. | Moth-Morane .. | 85 Gipsy .. | 90 | 68 | 9 | 936.07 |
| Lietard .. | Potez 36 .. | 95 Salmson .. | 90 | 70 | 10 | 992.16 |
| Mauler .. | Caudron 128 .. | 120 Salmson .. | 100 | 80 | 10 | 1,023.84 |
| Lalouette .. | Farman 231 .. | 95 Renault .. | 74 | 82 | 9 | 1,040.81 |
| Blauger .. | Potez 36 .. | 95 Renault .. | 100 | 78 | 10 | 1,103.78 |
| Hilsz .. | Moth-Morane .. | 85 Gipsy .. | 100 | 94 | 10 | 1,136.65 |
| Letartre .. | — | — | 110 | 72 | 9 | 1,141.13 |
| Pegulu de Rovin | Potez 36 .. | 95 Renault .. | 95 | 92 | 9 | 1,172.48 |
| Pharabod .. | Caudron 232 .. | 95 Renault .. | 120 | 70 | 6 | 1,230.56 |
| Durandau .. | Potez 36 .. | 95 Renault .. | 125 | 76 | 9 | 1,260.16 |
| Camion .. | Potez 36 .. | 95 Renault .. | 80 | 130 | 9 | 1,316.68 |
| Lardy .. | Farman 231 .. | 95 Renault .. | 117 | 118 | 3 | 1,570.58 |
| Burlaton .. | Caudron 230 .. | 95 Salmson .. | 140 | 120 | 10 | 1,612.26 |
| Martinoff .. | Potez 36 .. | 95 Renault .. | 160 | 117 | 10 | 1,717.68 |
| Grillot .. | Morane-Saulnier .. | 120 Salmson .. | 125 | 116 | 8 | 1,718.33 |



THE ONLY AMPHIBIAN: Front view of the Heinkel H.E. 57 six-seater. (FLIGHT Photo.)

I.L.I.S.

The Stockholm International Aero Show May 15-31, 1931

A brief outline of what there is to be seen at the Stockholm Aero Show was published in our issue of last week. Below we deal in more detail with such of the exhibits as may be assumed to be of interest to readers of "Flight"

BY making use of the Air Mail we were able last week to give our readers a general idea of the character of the International Aero Exhibition at present being held in Stockholm, Sweden. We remarked that England was but scantily represented, although we in this country produce types of aircraft, particularly in the private owner's class and small commercial class, which should be especially suitable for Swedish conditions. The amphibian type of aircraft in particular should appeal to Swedish flying people because the country has but few proper aerodromes, few fields large enough for emergency landings, but miles and miles of inland waterways and lakes, and sheltered bays along the coastline. The seaplane is definitely a more suitable type than the land-plane, but the amphibian is better still, provided the extra weight entailed is not prohibitive. No amphibian type is actually exhibited in the main building, but the Heinkel firm, of Warnemünde, sent over an amphibian flying-boat,

which spends its time partly ashore just outside the building, partly on the water in Lindarängsviken, and partly giving demonstration flights over and in the immediate neighbourhood of the exhibition. We in this country have an effective answer to the Heinkel in the Sanders-Roe SARO boats, such as the "Cutty Sark," "Windhover" and "Cloud," but they were not, unfortunately, to be seen anywhere. In the light plane class no amphibian was seen, and a machine such as the Short "Mussel" would, we feel sure, have attracted a great deal of attention. It was left to the Cierva Autogiro to represent British aircraft, and, in view of its ability to get out of small spaces and to alight in even more restricted areas, the type is undoubtedly very suitable for Swedish conditions. But the ordinary seaplane of more orthodox design is also well suited to Sweden's geography, and a few British examples would have been welcomed.

The seaplane, and more particularly the amphibian,



THE HEINKEL H.E. 57: In this three-quarter front view may be noticed the combined tail skid and water rudder. The airscrew tips pass very close to the windscreen and probably cause considerable buffeting. (FLIGHT Photo.)

being the type wanted in Sweden, it seems fitting to begin these notes with a description of the only aircraft of this class which made its appearance, *i.e.*, the Heinkel H.E.57.

The Heinkel Amphibian

Dr. Ernst Heinkel is one of Germany's pioneers, and his name has, almost from the very earliest days, been associated mainly with the twin-float seaplane type of aircraft. In this connection it is perhaps worth while recalling that before he formed his own company Dr. Heinkel was associated with the Hansa-Brandenburg firm, whose machines were not unknown to British pilots during the war. In the main, Dr. Heinkel has remained faithful to his earlier ideals, but this has not prevented him from producing from time to time machines other than float-planes. He has produced some very good landplanes, and at Stockholm he showed an even later type, the H.E.57, which is a boat-type amphibian, designed for passenger-carrying. A model of this machine was shown at the Paris Aero Show last December, and a photograph of this model was published in FLIGHT of December 12, 1930.

At Stockholm the Heinkel H.E.57 Amphibian arrived from Warnemünde (where the Heinkel factories are situated) piloted by Herr von Gronau, the German pilot who flew from Germany to New York, via Iceland and Greenland, on a Dornier Wal last year. The advantages of the amphibian were demonstrated in a small way at once, in that Herr Gronau was able to alight on the water outside the exhibition and taxi on to the slipway, and then, with wheels lowered, bring the machine right up on the shore just outside the main exhibition hangar.

The Heinkel H.E.57 is a strut-braced high-wing monoplane amphibian flying-boat of mixed construction. The hull is mainly built of Duralumin, while the monoplane wing is largely of wood construction.

Although of the two-stepped type, the hull of the H.E.57 differs in its lines very materially from the majority of British flying-boat hulls, even from those of the well-known SARO boats with which the Heinkel may best be compared, because of its flat-sided hull. It is true that the Heinkel resembles other British boats in that it has two steps (the SARO boats having but one), but the general layout of the machine is more than that found in the boats of Mr. Knowler's design. The forward main step of the Heinkel is very like those found on all British flying-boat hulls, with a fairly pronounced vee, but the rear step is of totally different design, in that it resembles more the heel of a seaplane float, terminating in a vertical stern post which merges into the bottom of the rear, cocked-up portion of the main hull. This vertical stern post carries a water rudder by means of which the machine can be manoeuvred while taxiing, and also forms a tail skid when the machine is used as a landplane.

Constructionally, the boat hull is fairly orthodox, the flat sides simplifying the construction of the frames and planking. The bottom, from the bows to the rear step, has a pronounced vee, that ahead of the main step being a vee with curved planes, while aft of the main step the vee is of the straight-lined type. Two watertight bulkheads divide the boat into three compartments, of which the middle forms the cabin of the machine. In the forward compartment is stowed the marine gear, etc., and this part is reached either through a hatch in the forward deck or through a watertight door in the cabin bulkhead. The rear part of the hull, aft of the rearmost bulkhead, does not contain any load or equipment, but a watertight door in the bulkhead gives access to it for purposes of inspecting the controls and the interior of the boat hull.

In the middle part of the interior of the hull is arranged the cabin and cockpit equipment, which consists of the usual chair seats, with a gangway down the centre. There are seats for four passengers, and the two seats for the



A CLOSE-UP OF THE HEINKEL: The engine is a Pratt & Whitney "Wasp." Note the hatch which gives access to the cabin. (FLIGHT Photo.)

crew are placed side by side, and not separated from the passenger cabin. In the roof there is a celluloid skylight, while in the sides of the cabin are rectangular glass windows. Around the sides and front of the forward part of the cabin are also glass windows of unsplinterable glass, the side windows being arranged to open and serving, in case of accident, as emergency exits for the crew and passengers. The cabin is reached through a hinged hatch in the deck, visible in one of our photographs.

The land undercarriage consists of a tripod on each side, axle and radius rod being hinged to the sides of the hull, while the telescopic leg is attached near the top, at the point where the front wing spar fitting is mounted on the hull. The telescopic leg is of the oleo type, and raising the wheels is accomplished hydraulically by means of a hand-operated pump in the cockpit, next to the pilot's seat.

The monoplane wing is of mixed construction, with wooden spars and duralumin ribs, covered with fabric. The wing is braced by a pair of vee struts on each side, the lower end of the vee being attached to the sides of the hull approximately at waterline height. This position might be expected to make the boat slightly "dirty" during take-off, but, as we did not see the machine take off during our stay in Stockholm, we are unable to state from personal observation whether this surmise is correct or not. Wing-tip floats are attached at the points on the wing spars where the lift strut fittings occur, and, owing to the fact that the machine is a high-wing monoplane, the struts supporting the wing-tip floats are unusually long. Laterally, the wing-tip float supports are braced by nearly horizontal struts to the main wing bracing struts, and thence by vertical struts back to the wing spars.

A Pratt & Whitney "Wasp" engine is the standard power plant of the H.E.57, but, if desired, a "Hornet" can be substituted to give a better performance. The engine is mounted on struts above the wing, and drives a metal airscrew with blades adjustable for pitch. The airscrew blade tips pass very close in front of the windscreen, and one would expect the beating of the air on the screen to cause considerable buffeting and noise in the pilot's compartment. Another disadvantage of arranging the engine as a tractor instead of as a pusher is that, when on the water, and manoeuvring up to a buoy or anchorage, the member of the crew who is working from the forward hatch has the airscrew fairly close behind him. It is true that the hatch cover is so designed as to rest at a considerable angle with the deck, and thus to afford some protection, but one cannot help thinking that the Heinkel amphibian, like a good many other machines, would be improved in many ways if the engine were



GERMANO-SWEDISH ALLIANCE: A two-seater fighter of Junkers design, the K.47, built under licence in Sweden by the A.B. Flygindustri, of Malmö. Note the twin-rudders intended to give the gunner a better field of fire.

turned around and made to drive a pusher airscrew. The main petrol tanks are placed in the wings, one on each side of the hull, and supply to the engine is by engine-driven petrol pumps. In the fairing behind the engine is, in addition to the oil tank, a small reserve petrol tank, separated from the engine by a fireproof bulkhead.

The Heinkel H.E.57 amphibian has a wing span of 16 m. (52 ft. 6 in.), and a wing area of 39.2 sq. m. (422 sq. ft.). The tare weight is 1,550 kg. (3,410 lb.), and the gross weight 2,450 kg. (5,380 lb.), so that the ratio of gross weight to tare weight is 1.58 to 1, a figure which is to be regarded as quite good for an amphibian type of aircraft. With a wing loading of 62.5 kg./m.² (12.75 lb./sq. ft.), and a power loading of 5.45 kg./h.p. (12 lb./h.p.) (based on 450 h.p.), the maximum speed is 195 km./h. (121 m.p.h.). The landing speed is given as 93 km./h. (58 m.p.h.), and the climb to 1,000 m. (3,280 ft.) in 5 min.

The other Heinkel machine which arrived for the exhibition was of more familiar type, and was, in fact, similar to those which have been in use in Germany for a number of years, so that a detailed description scarcely appears necessary.

Dr. Claudius Dornier was represented at the I.L.I.S. by a "Wal" of normal type, fitted with two water-cooled engines. Like the Heinkel float seaplane, this also is familiar to our readers, and does not call for comment here.

Inside the main exhibition building, the only German aircraft exhibited was, as recorded last week, a Junkers "Junior" with Siemens engine. This machine is, of course, well known to our readers, and the mere mention of its presence at Stockholm will suffice.

The problem single-seater or two-seater fighter is a very complicated one, and does not come within the province of an article on the exhibits at an aero show. A brief reference must, however, be made to it in order to explain

the *raison d'être* of the machine shown by the Swedish company, A.B. Flygindustri, of Malmö. This is a two-seater fighter known as the type K.47, and is a Junkers design built under licence in Sweden by this company, who holds the building rights in Sweden for all Junkers types.

From strategical and tactical considerations, this firm has come to the conclusion that a flight of five two-seater fighters is equivalent in offensive and defensive power to a flight of seven single-seater fighters. These considerations, into which it would take too long to go here, take into account the "blind areas" of both types, the increase in effective field of fire attained by the climbing or diving through 60 degrees from the horizontal, the inability of the rear machines in a flight to fire in certain forward directions owing to the positions of certain machines of the flight, the various formations, such as vee formation stepped up and stepped down, and so forth. The arguments advanced in favour of the two-seater fighter are interesting, and may be referred to on a future occasion. For the present, we must confine ourselves to stating that A.B. Flygindustri have gone into the subject very carefully, and that the K.47 has been produced as a result.

The machine, by the way, is not unknown to English readers of FLIGHT, as it paid a visit to Heston Air Park in 1929, and a photograph of it was published in our issue of July 25, 1929. Like all Junkers aircraft, the K.47 is of all-metal construction, but it differs from most Junkers machines in that it is not a cantilever monoplane, but has a braced wing structure. It is stated, however, that the load factors are such that, even with a wing bracing strut shot away, the wing, as a cantilever, has a factor of 4-5, so that the machine should be able to return safely, even if not in a fit state to take any further part in a fight entailing violent manoeuvres.

The structural design of the K.47 follows fairly closely



DORNIER'S CONTRIBUTION: A "Wal" at one of the slipways in Lindarångsviken. (FLIGHT Photo.)



ANOTHER HEINKEL AT STOCKHOLM: This twin float cabin seaplane is of more typical Heinkel appearance than the amphibian illustrated on previous pages. (Flight Photo.)

usual Junkers practice, with the exception of the wing bracing already referred to. Duralumin is the chief structural material, with a few steel fittings for highly-stressed parts. The torsional strength of the wing depends mainly upon the duralumin covering, which, it is claimed, can be riddled with machine-gun bullets without the torsional strength being materially reduced.

The pilot's cockpit of the K.47 is of normal layout, and his armament consists of the usual two fixed machine guns, firing forward. The gunner's cockpit, however, is the centre of interest in this machine, and is the key to the whole design. The fuselage is so shaped as to obstruct the view and field of fire as little as possible. To this end it is of narrow beam over the rear part, while the tail is set low, and the decking slopes down at a considerable angle. This has been done so as to enable the gunner to fire downward at a slight angle (some 3 degrees) below the horizontal. The upward angle of the gun is 90 degrees, so that the total elevation range is 93 degrees. Firing broadsides at the speeds attained by modern fighters is regarded by the designers as almost impossible in any case, and so no attempt to allow of this has been made. Instead, the lateral movement of the rear gun has been limited to 18 degrees on each side of the centre line of the machine, or a total of 36 degrees. This amount of traverse is entirely unobstructed, because, instead of the usual centrally-placed rudder, the K.47 has two rudders, placed near the tips of the tailplane. In this position they are outside the range of the gun, and there is thus no risk of the gunner shooting his rudders or fins away.

The gun mounting is interesting, and is of a type known in Sweden as a "gunglavett," a "gung" being a rocker (of a rocking-horse, for example), and "lavett" meaning a mounting. This "rocker-mounting" consists in effect of a beam supported near its centre on a pivot, and carrying at one end the machine gun and at the other the gunner's seat. Its object is to enable the gunner to operate his gun even while the machine is making a very sharp turn, when otherwise centrifugal force would prevent him from moving about. Windage on the gun when it is swung outboard to the limits of its traverse is counteracted by a spring device, the strength of which is so proportioned to the angle of the gun as to keep the force required to traverse approximately constant.

The gunner's seat has a tall backrest, tall enough to reach to head level and enable the gunner to rest his head firmly against it. A projection of the deck fairing between the cockpits acts as a wind-screen for the rear gunner and relieves his head and neck of most of the air pressure. The whole arrangement of the rear cockpit is highly ingenious, but the "rocker mounting" would appear to be just a little complicated.

The K.47, which is fitted with a Bristol "Jupiter" VII

supercharged engine, has a length of 8.55 m. (28 ft. 1 in.). The wing span is 12.4 m. (40 ft. 8 in.) and the wing area 22.8 sq. m. (245.5 sq. ft.), the tare weight is 1,050 kg. (2,310 lb.) and the gross weight 1,635 kg. (3,600 lb.).

When fitted with the Bristol "Jupiter" VII supercharged engine, the K.47 has a maximum speed at 3,500 m. (11,500 ft.) of 290 km./h. (180 m.p.h.). At 5,000 m. (16,400 ft.) the speed is 280 km./h. (174 m.p.h.). The speed at ground level is 245 km./h. (152 m.p.h.). The landing speed is about 100 km./h. (62 m.p.h.). The climb to 3,000 m. (10,000 ft.) occupies 6 minutes, and the service ceiling of 8,500 m. (28,000 ft.) is reached in about 35 minutes. The tankage is sufficient for 2 hours at full throttle and 16,400 ft. altitude.

Svenska Aero A.B. show a single-seater fighter "Jakt-falk" with "Jupiter" engine. This machine, first produced in 1929, was originally designed for the Armstrong Siddeley "Jaguar," with which the first machine was fitted. The example shown has been slightly altered, but is substantially the same as the original machine. We were never able, during our stay at the exhibition, to find anyone in charge on the stand, and so have not been able to collect data of the machine.

As briefly recorded last week, the A.B. Svenska Järnvägsverkstäderna Aviation Department exhibit the first machine produced since the Swedish Railway Works of Linköping established an aviation department. The machine has a strong resemblance to such British machines as the "Puss Moth" and the Desoutter monoplane. The machine was finished a few days before the opening of the Stockholm Aero Show, and so has not been flown yet, nor are photographs of it available. It is a high-wing three-seater cabin monoplane of mixed construction, the fuselage being of welded-steel tube and the wing mainly of wood construction. The wings, braced by steel tube vees, are designed to fold as in British machines. The cabin is arranged with a single seat in front for the pilot, and a sofa seat for two behind him. There is a large luggage space behind the sofa seat.

The undercarriage has telescopic legs with oil-damped springs, and wheel brakes are fitted. Float and ski type undercarriages can be substituted. The engine is an inverted Cirrus-Hermes. As a landplane the machine has a disposable load of 385 kg. (850 lb.), and as a seaplane the disposable load is 300 kg. (660 lb.). It is estimated that the maximum speed will be about 175 km./h. (109 m.p.h.), while the estimated cruising speed is 150 km./h. (93 m.p.h.). At this speed the cruising range should be about 800 km. (500 miles). For a first attempt the "Viking" is a very creditable effort, and we hope to publish fuller details when the machine has been flown and thoroughly tested.

AIR TRANSPORT



Three-quarter front view of the Savoia-Marchetti "S-71" commercial monoplane, fitted with three 240 h.p. Walter "Castor" engines and accommodating eight passengers.

THE SAVOIA-MARCHETTI "S-71"

An Italian Three-Engine High-Wing Commercial Monoplane

THE high-wing cantilever monoplane, of the type introduced some time back by the Fokker Company, has gained considerable popularity in many countries of late, especially multi-engined models. Just recently the well-known Italian aircraft firm of Savoia-Marchetti has produced a commercial machine of this type in the "S-71," of which we are able to give below some brief particulars.

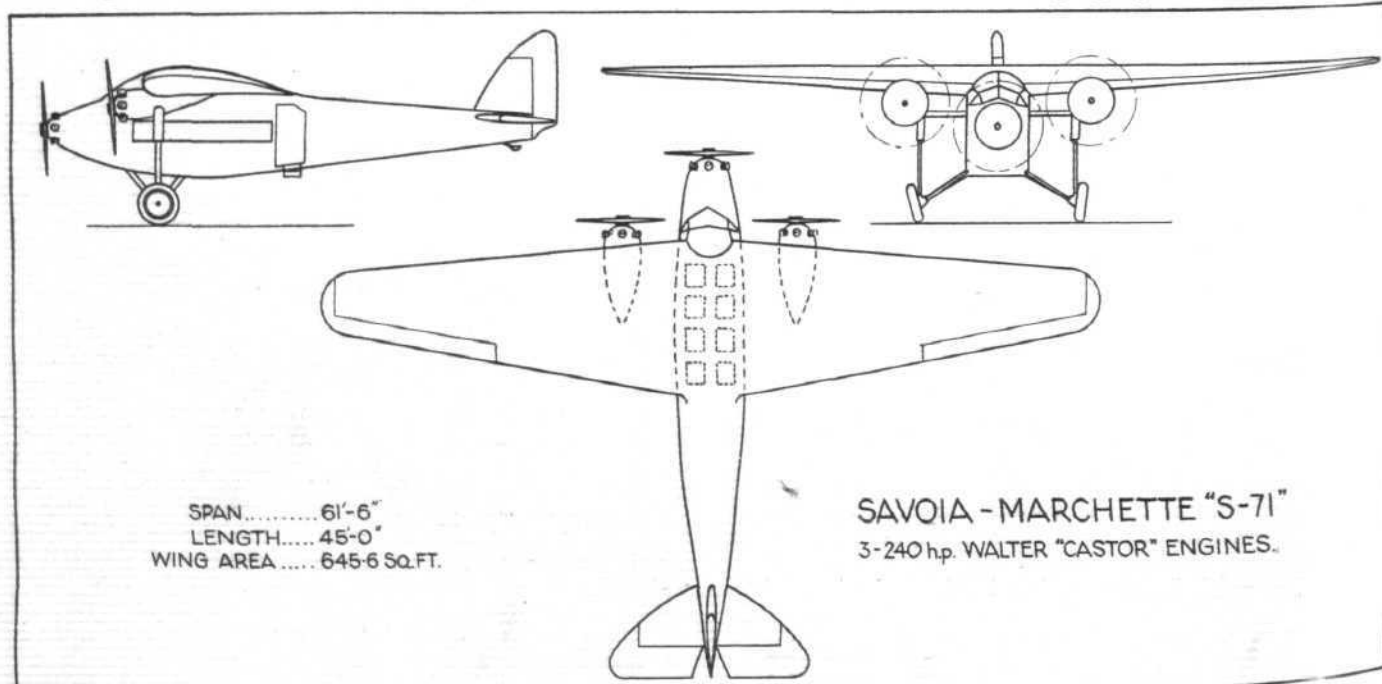
The "S-71" is a medium-powered machine intended for air lines having fairly big traffic. It is claimed that this type of machine, together with its individual features and aerodynamic qualities, presents something entirely different to other machines at present in use for mail and passenger service in Italy.

As will be seen from the accompanying illustrations, the "S-71" has a fairly thick cantilever wing, tapering in chord and thickness from root to tip, mounted on top of the fuselage, and is equipped with three engines, one mounted in the nose of the fuselage and two mounted on the wings, on either side of the fuselage.

The wings, which are similar to those used on the "S-55" seaplane and the "S-64 bis" monoplane, which established a world's record for duration and distance in a closed circuit, are constructed entirely of wood, having three box spars and three-ply covering. Four duralumin petrol tanks are mounted inside the wings.

Welded steel tubing is employed for the construction of the fuselage, and the central engine mounting—which we believe is detachable—enables different types of engine to be installed. Immediately behind is the pilot's cockpit, at the leading edge of the wing. Dual control is provided, with side-by-side seats, and the cockpit is completely enclosed by glass windows, the whole merging neatly into the streamline of the fuselage and wings.

The passengers' cabin comes immediately behind and below the pilot's cockpit; it has a capacity of 424 cu. ft., and accommodates eight passengers with the maximum of freedom and comfort—the height of the cabin being 6 ft. Comfortable armchair seats are arranged on each side of the cabin, with a central gangway between, and sliding



The Savoia-Marchetti "S-71" General arrangement drawings.

glass windows extending continuously the full length of the cabin provide an excellent view below. It is claimed that these windows, when open, are sufficiently large to enable the passengers, if need be, to jump therefrom with their parachutes.

At the rear of the cabin are a lavatory and the luggage compartment. A large door on the left-hand side of the fuselage, just at the rear of the cabin, provides easy entrance and exit.

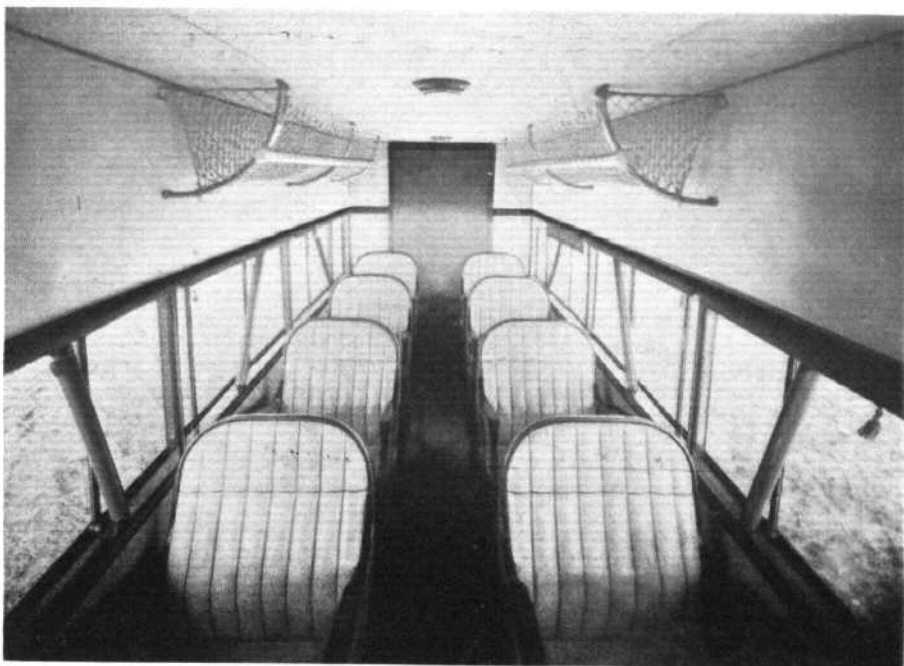
The tail surfaces are of the monoplane type, the horizontal stabiliser being adjustable as to incidence during flight, while the vertical fin can also be adjusted when on the ground. These tail surfaces are all constructed of wood, with three-ply covering. The elevators and rudder have horn balances, as have also the ailerons.

The landing gear is of the non-axle type, the wheels being hinged to the fuselage by steel V-members, landing shocks being taken by Oleo-pneumatic struts extending up from the wheels to the wing-engine mounts. Oleo-pneumatic brakes, with differential control, are provided. A strong tail-skid, suitably sprung, is fitted.

As previously stated, the power plant consists of three engines, one mounted in the nose of the fuselage, and the others on the wings. These latter engines are carried in steel mountings, slung from the front wing spars, neatly faired into the wing by metal cowlings.

The engines installed in the machine illustrated are 240 h.p. Walter "Castor" air-cooled radials, equipped with two-bladed adjustable metal air screws. Starting is by compressed air, with Garelli motor-compressor.

The following performance figures for the "S-71" have been issued. With two wing engines in action and a full load of 3,748.5 lb., the machine takes off in 30 sec. in a run of 416 yards, climbs to 3,281 ft. in 10 min., to 6,500 ft. in 22 min., and to 9,800 ft. in 51 min., and has a maximum horizontal speed of 130.5 m.p.h. With one engine in action and 2,205 lb. load, the machine will main-



An interior view of the cabin of the Savoia-Marchetti "S-71."

tain level flight, or with full load with a drop of 4 per cent. One of these monoplanes recently flew from Milan to Rome in 2 hr. 45 min., and, piloted by Alessandro Passaleva, established an altitude record, with 2,000 kg. load of 6,540 m. (21,457.7 ft.).

The principal characteristics of the Savoia "S-71" are: Span, 69 ft. 6 in. (21.2 m.); overall length, 45 ft. (14 m.); height, 13 ft. 6 in. (4.1 m.); wing area, 645.6 sq. ft. (60 sq. m.); weight empty, 6,174 lb. (2,800 kg.); weight laden, 9,922 lb. (4,500 kg.); pay load, 1,874.25 lb. (850 kg.); speed range, 62-146 m.p.h. (100-235 k.p.h.); cruising speed, 124 m.p.h. (200 k.p.h.); climb, to 3,281 ft. (1,000 m.), 3 min.; to 9,800 ft. (3,000 m.), 14 min.; to 19,686 ft. (6,000 m.), 54 min.; duration, 8 hours.

Parcel Air Service to India

A DIRECT weekly air parcel post service to India commenced on May 23. The air parcels will be conveyed by air from London to Karachi by the aeroplanes performing the England-India air mail service, which leaves London every Saturday morning and is due to reach Karachi the following Thursday afternoon. The inclusive rate of postage is 6s. per lb. or fraction thereof, up to a maximum of 20 lb. The latest time of posting at the General Post Office, London, will be 9.0 p.m. on Fridays (the latest time of posting elsewhere can be ascertained at the local Head Post Office), and the air parcels will be due to be delivered in Bombay and Delhi 8 days, and in Calcutta and Madras 10 days, after despatch from London. The new service thus affords appreciable acceleration over the ordinary parcel post routes to India, which occupy 17 days (via France) and 23 days (by sea direct) in transit to Bombay. The general parcel air mail regulations apply to the service, which is confined to parcels addressed to India, and is not available for other countries on the route. Air parcels for India cannot be insured.

Wilson Airways, Ltd.

ONE does not hear in England very much of what is being done by some of the "local" air transport concerns in certain of our Colonies. A case in point will be found in Wilson Airways, Ltd., which has been quietly carrying on air transport work in East Africa for some time past. This company, which is owned by Mrs. F. K. Wilson, with Mr. T. Campbell Black as managing director, has its headquarters at Nairobi, and is, we believe, the only air transport company operating in Kenya. Wilson Airways not only operate a regular air service, but also do a fair amount of air-taxi work and flying instruction. They are also agents for the de Havilland Aircraft Co., Ltd., A. V. Roe, Ltd., and Lodge Aviation Plugs. As regards the latter, it may be of interest to note that, in connection with the flight across Africa by Mr. Mostert, to which we referred last week, Lodge Plugs, Ltd., of

Rugby, received the following letter from Mr. Mostert:—"On February 24, 1931, I started on a flight with a 'Puss Moth,' fitted with a 'Gipsy III' engine, from Zanzibar, across Africa to Dakar, and then along the west coast of Africa to London, where I arrived on Sunday, April 12. Prior to leaving Zanzibar I fitted to the engine eight Lodge plugs. During the flight the engine ran 80 hours 40 minutes, and I never even removed the plugs from the engine. There was no necessity to do so. They are still in the engine, as they were screwed in at Zanzibar. These plugs gave every bit of satisfaction, and when I return to Kenya, in fourteen days' time, shall use them again."

Another fine flight recently accomplished by Wilson Airways was a 1,000-mile "hop" in a "Puss Moth" at an average speed of 110 m.p.h. This was from Nairobi to Dar es Salaam, Zanzibar, Mombassa, and back to Nairobi. The W.A.L. fleet consists of two Avro V's, two D.H. "Puss Moths," and two D.H. "Gipsy Moths."

Air Taxis for Atlantic Liners

ARRANGEMENTS have been made by Imperial Airways for "air taxis" to meet Atlantic liners at Cherbourg on their arrival from America and take passengers by air direct to London, saving 12 hours on the journey from America to London. Machines, ranging from a single-passenger Moth to a triple-engined Armstrong-Siddeley air liner seating 20 passengers, will be available for this service, the fare for which will be approximately £15 per passenger.

Military Civil Machines

ACCORDING to the *Morning Post* Shanghai Correspondent, a stipulation in the contract which the China Nationalist Government has decided to place with a British firm for 40 commercial aeroplanes is that they must be equipped with light machine-guns, in order to meet any possible danger from bandits. The aeroplanes have been ordered to facilitate the improvement of the existing Chinese commercial air services and to establish new air routes.

AIRPORT NEWS

CROYDON

AS usual, we have nothing for which to thank the elements again this week as regards business, and yet, generally speaking, business has been good, and the holiday week-end has been one continual rush, many services having been duplicated, and in some cases triplicated. Imperial Airways could have put "Hannibal" to good use, but this particular specimen has still failed to appear. It has become a standing joke at Croydon, and every day one hears: "Don't say a word, but I've heard 'Hannibal' is coming to-day!" and so the days pass. Really, everyone is beginning to doubt his existence at all.

Imperial Airways have now instituted a "Dawn Patrol." This is a freight service operated with the Handley-Page W.10's, and it leaves at crack of dawn daily, much to the annoyance of many local residents, as it seems to make more fuss getting away than any of the other machines during the night.

On Wednesday night the Air Ministry chartered an Argosy to carry out extensive tests of new ground lighting. Mr. Walters was the pilot, and he had on board Colonel Sheldermine and various Air Ministry officials. Special tests were also made on wireless bearings by night. After leaving Croydon the machine visited Dungeness, Dover, Deal, Canterbury and Chatham. I understand that the whole test was most satisfactory from every point of view, and some very valuable data were collected.

The Air Union are speeding-up their freight services, and for this purpose they have had several of their older "Lioré et Oliviers" converted. These machines are easily one hour faster on the trip than the old "Farman Goliaths," which are slowly being replaced. The Farman have, nevertheless, done very stout service over many years past, and, although everyone now treats them as ancient chariots, I do not suppose they owe the Air Union anything. They have been plodding along backwards and forwards now for 11 years past, but modern hustle demands something quicker, and this company are not going to be left behind.

British Air Transport, Ltd., have now acquired a three-seater Klemm monoplane, which is eventually to be sent

away on a joyriding mission. On Friday Capt. Douglas Mail left at dawn on one of the company's Puss Moths for Africa. I mentioned last week that B.A.T. were opening a new branch out there. He arrived the same evening at Pisa, not bad going considering he had been up nearly all the previous night at a farewell party given by the firm. Incidentally, the progress of B.A.T. will be interesting to watch; they seem to be out for big game, and not content to sit and hold tight. Some of the other taxi firms would do well to follow their example.

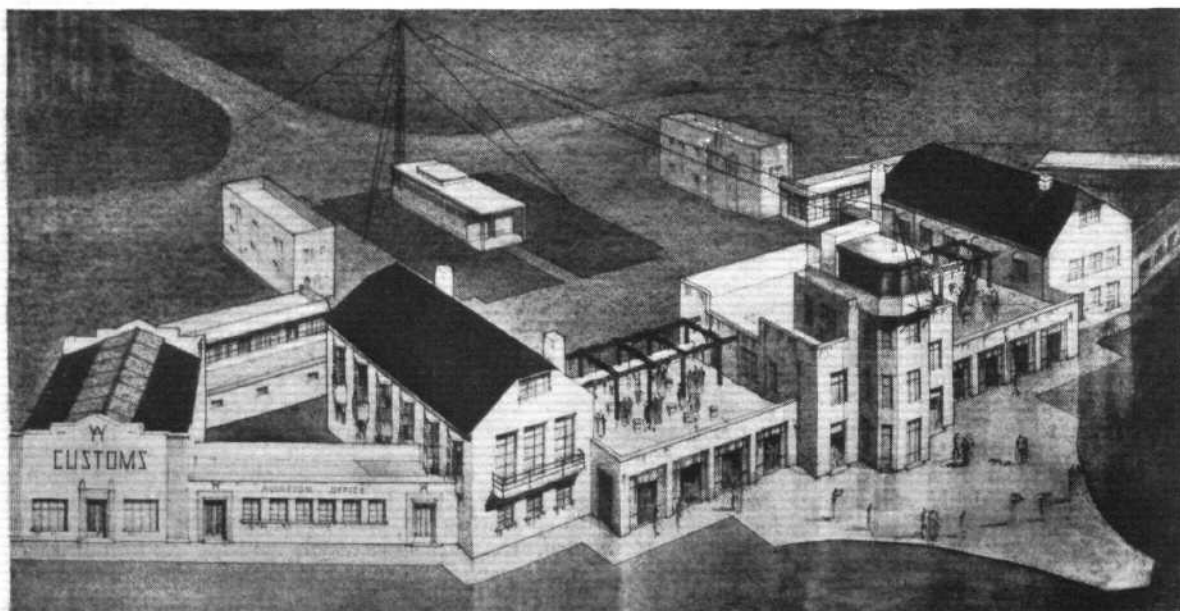
Personal Flying Service, Ltd., have now started a regular week-end service to Le Touquet. Their machines leave Croydon twice daily, and, of course, leave Le Touquet twice daily, and the service is amplified if necessary. Their fleet consists of a Junker, Desoutter and a Sikorsky. Major Nobby Clarke is the "chargé d'affaires."

We shall soon hear some of our worthy Air Ministry friends on the "talkies," as the Gaumont Sound News were busy recording in the Control Tower on Saturday. This will undoubtedly make an interesting subject from the screen, and ought to give the public a good idea of how traffic is controlled in the air. It is doubtful if many people realise what care is taken in this matter.

We were given an opportunity of seeing the C.A.C.2, of the Civilian Aircraft Co., during the week. This is the first visit of this machine to Croydon, and it was flown over by Mr. Pennington, of N.F.S. It was greatly admired, and certainly appears to be a beautiful little job.

Mr. Whistlecroft, of the Marconi Co., caused much merriment early in the week when he was seen walking round the Aerodrome with a box under one arm, a piece of wire on a stick over his head and a telephone in his hand. He was talking into the telephone whilst marching up and down, like a soldier on parade. It appeared he was testing an experimental one-man wireless station. The transmitter, I understand, has a range of approximately one mile, and is worked from batteries only. The experiment was very successful, but it certainly looked curious from an onlooker's point of view.

The traffic figures for the week were:—Passengers, 935; freight, 70 tons.



HESTON IMPROVEMENTS: An architect's drawing showing the Club House and adjoining buildings at Heston Air Park as they will appear when improvements now on the way are completed. The additions include (1) (Adjoining the Customs) An enlarged Aviation Office with Foreign Exchange facilities. (2) Enlarged restaurant and dormy rooms, each with bath adjoining. (3) A row of shops on the left behind the Customs. These will be used by Aerofilms and others having business at Heston. (4) The A.A. Weather Bureau shown at the foot of the wireless mast where the first of the proposed new A.A. meteorological broadcasting stations will be housed.

The AIRCRAFT ENGINEER

FLIGHT
ENGINEERING
SECTION

Edited by C. M. POULSEN

May 29, 1931

CONTENTS

| | |
|---|----|
| Hull Design of Flying Boats. By William Munro, A.M.I.Ae.E.... | 33 |
| On Solid Rivets. By M. Langley, A.M.I.N.A., A.M.I.Ae.E. | 36 |
| Technical Literature | 40 |

HULL DESIGN OF FLYING BOATS.

By WILLIAM MUNRO, A.M.I.Ae.E.

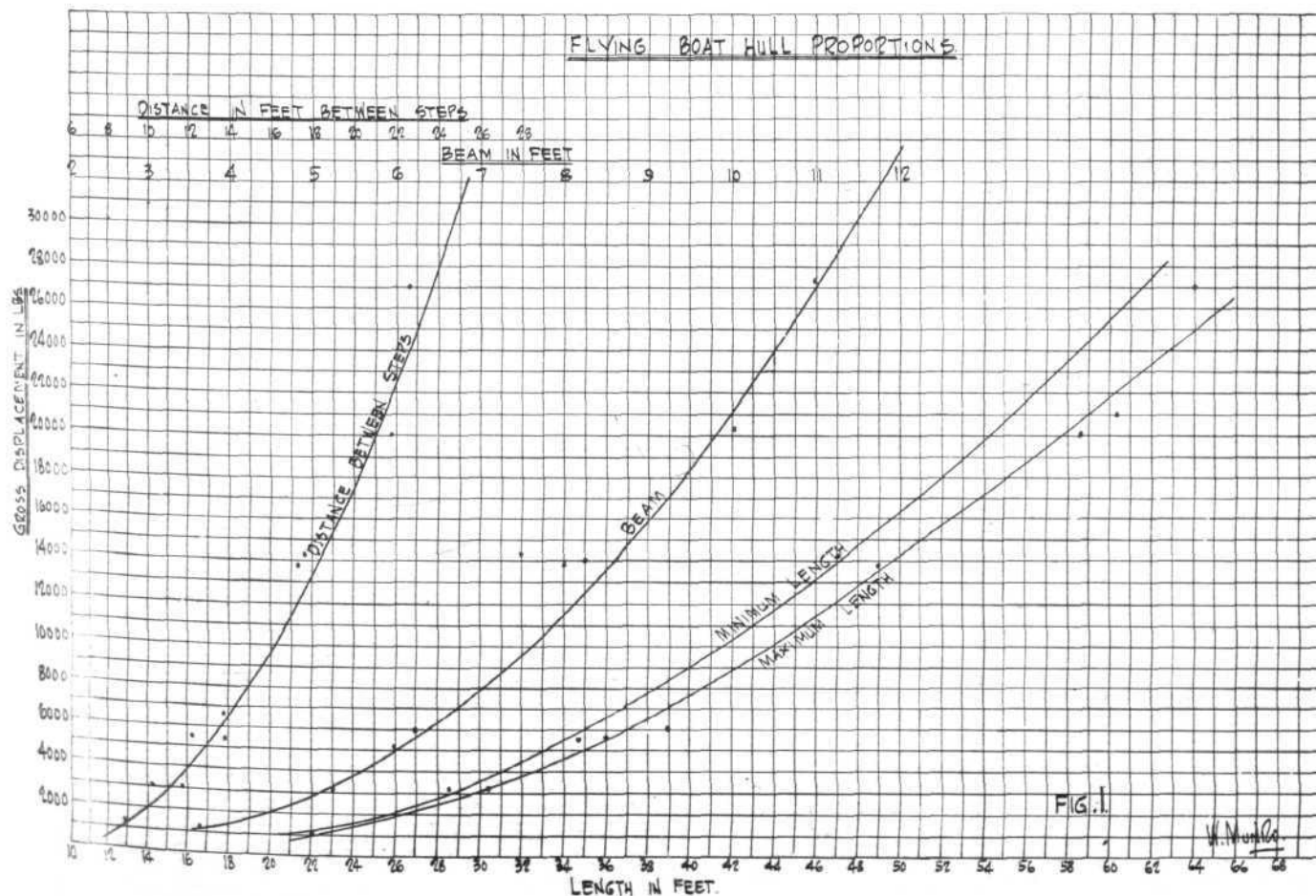
If the hull design of a flying boat is sufficiently bad, the machine will never get into the air to demonstrate its aerodynamic qualities. In the design, therefore, of

any flying boat the characteristics of the hull must be given early attention.

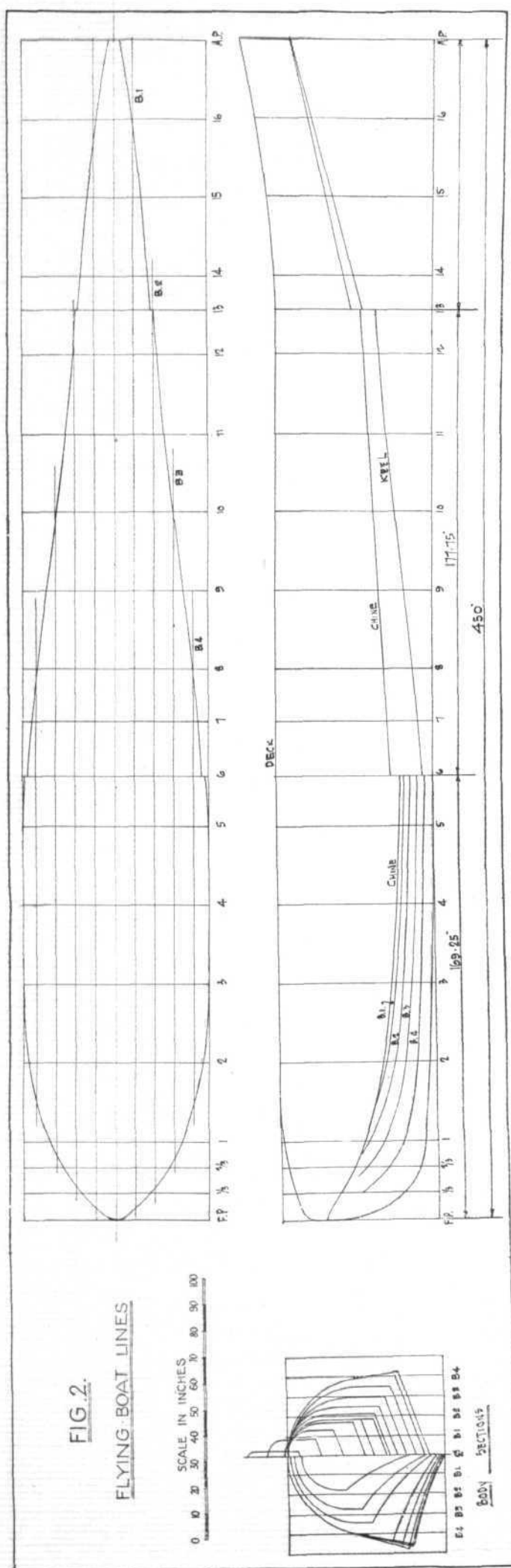
In the present article it is proposed to describe briefly the type of flying boat hull most generally used in England and to indicate the main reasons for its adoption. The type referred to is that having a vee-shaped planing bottom and two transverse steps, and built of either duralumin or Alclad.

General Principles.

Size of Hull.—The size of the hull is governed by the degree of seaworthiness required for the particular design being considered, since obviously a boat operating,



THE AIRCRAFT ENGINEER



say, from river bases will not require the same free-board—or distance from load waterline to deck—as one operating in unprotected waters. A reserve of buoyancy of five hundred per cent. is usually considered necessary for commercial machines. Passenger accommodation, head-room, &c., are often the governing features of the design.

Length of Hull.—The length of the forebody, that is to say, the distance from the bow to the first step, must be sufficient to prevent any tendency to wallow, or, putting it another way, the volume forward of the centre of buoyancy must be such that the forward portion of the hull, when submerged, will have a restoring couple sufficient to retard the downward movement due to the thrust of the propeller while taxiing.

The distance between steps is governed by:—

1. The height of the centre of gravity above the load water line.
2. The height of the propeller, its thrust, and the lift of the tail, account being taken of the propeller slip stream.

The overall length of the hull is greater for a monoplane than for a biplane, and is determined by making the distance from the centre of gravity of the boat to the rudder post approximately three times the mean wing chord.

Beam of Hull.—A consideration of the beam necessary is usually the starting point on any new hull design. This may be taken as a measure in inches of about four times the cube root of the displacement in lbs.

Steady running is of first importance, since even small changes in the trimming angle produce large changes in the immersed area.

Steps.—It is the writer's opinion, after some experience of both types, that the two-step hull is steadier running than the one-step type. The latter is more under the control of the pilot at take-off, but before that speed is reached is more than likely to give trouble by porpoising badly. In America, where the one-step type was at one time the standard model, the tendency now seems to be in favour of two steps, the rear one, however, being a longitudinal step, as seen on the Sikorsky and Fokker amphibians. This type, though much steadier in running, is not so clean running. The longitudinal step compares very unfavourably in respect to water drag.

The slight downward curve towards the rear step shown on Fig. 2 helps to hold the plane down till a greater air speed has been reached, and is a desirable feature in this respect, that it leaves the pilot free from the necessity of fine control on the run to take-off.

This, of course, is not intended to infer that the taking-off speed should be high. A low taking-off speed and a short run to take off are very desirable. Where small lakes and rivers are being used as take-off points, these features are essential. Again, in rough water the less time taken to get off, the less is the risk of damage to the hull structure from the waves. Since these requirements conflict with load carrying requirements, a compromise is generally made to suit the particular case and conditions of operation.

Several attempts have been made to do without a step in the planing bottom for structural reasons. Obviously, the break in longitudinal members occasioned by the existence of a step demand special attention in construction, which in turn means time and cost and additional structure weight. Further, the steps create added air resistance. Despite these serious objections the step is essential to satisfactory hull design. The function of the step is to break down the water suction and enable the plane to "unstuck" from the water. It is extremely difficult to counteract the water moments acting on a step-less hull with ordinary horizontal tail surfaces. As far as one knows, no successful flying boat has ever been built which did not have at least one step.

THE AIRCRAFT ENGINEER

Planing Bottom.—The vee shape of planing bottom is favoured because of its superiority to the flat bottom in absorbing the shock of landing, and in addition can be made adequately strong, with considerable saving in weight as compared with the flat bottom.

The dead rise or angles from keel to chine are chosen to give dynamic stability and good take-off. Clean running is obtained by making the fore body sections slightly concave.

Determination of Lines of Hull.—To determine the lines of the hull which will ensure clean and steady running and good take-off qualities, many different formulæ have been devised. Probably the most reliable method, however, is to follow the shipbuilders' system of utilising a known successful form as the basis of the new design and submitting a scale model thus developed to tank tests. In a new design, however, for a flying boat of unique lay-out, where no similar ship could be used as a basis, the model would be developed by trial and error, bearing in mind the fundamental principles already stated.

For a ship of conventional design the designer holds to certain proportions which can reasonably be relied on to give good results, since these are based on the known behaviour of numerous full-scale flying boats. The main proportions are:—

1. Proportion of beam to displacement.
2. Proportion of nose to step distance.
3. Proportion of length to beam.
4. Distance between steps.

Fig. 1 shows a graph of these proportions which has proved useful when starting new hull design. The lines plotted are the mean of a large number of known successful flying boats.

Item 1.

The maximum beam in inches is taken as four times the cube root of the displacement in lbs.*

Items 2, 3 and 4.

These dimensions are arrived at by using a multiplier derived from the cube root of the ratio of displacements. For example, if the known ship has a total displacement of 6,000 lbs. and a beam of 73 inches, then the beam of a new ship of 8,000 lbs. total displacement would be

$$\sqrt[3]{\frac{8,000}{6,000}} \times 73 \text{ inches.}$$

Keel heights above datum, chine heights, chine half-breadths and all other linear dimensions would similarly be proportioned up from the known hull by multiplying these by

$$\sqrt[3]{\frac{8,000}{6,000}}$$

The wing and power loading of the two ships should be approximately equal.

A set of lines drawn up from the figures obtained by this method will give a shape of hull possessing very nearly the same characteristics as the original. Before starting constructional work, however, it is advisable to have tank tests made. The method of proportioning up should be looked on as a quick means of arriving at reasonably good lines which can be cleaned up by investigation in the tank.

A set of hull lines is shown in Fig. 2. The upper structure shown is of the simplest form, and would, of course, be modified for the particular requirements of the design in hand. The planing bottom lines shown have been proved successful in practice, although a more pronounced turn-down at the chine would probably result in even cleaner running.

Fig. 3 gives the tables of offsets for the lines shown in Fig. 2.

Master Curve for Planing Bottom.—In the layout of a concave vee planing bottom, a master curve can be

* See "Seaplane Developments" by Major R. E. Penny in "The Journal of the Royal Aeronautical Society," September, 1927.

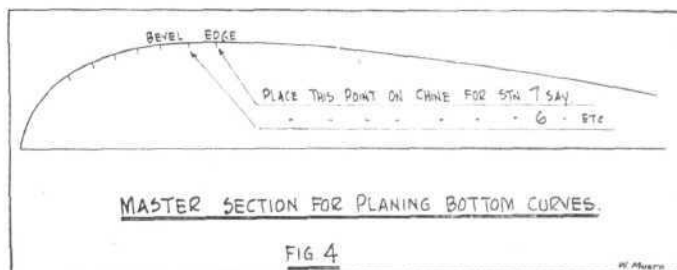
HULL OFFSETS.

| STATION | DISTANCE FROM NOSE | DISTANCE APART | ABOVE DATUM - | | | | | | | | CHINE HALF-BREADTH | CHINE DECK RADIUS |
|---------|--------------------|----------------|----------------|------------------|-----------|-----------|-----------|----------------|---------|----------------|--------------------|-------------------|
| | | | KEEL | BUTTOCKS - 7.42" | | | | CHINE | DECK | | | |
| | | | | B1 | B2 | B3 | B4 | | | | | |
| FP | 1 | 1 | 43.37 | | | | | 43.37 | 5" RAD- | 5" RAD- | 1 | |
| 1/3 | 10 | 10 | 13.25 | 29.30 | | | | 37.70 | 54.3 | 13.1 | 13.1 | |
| 2/3 | 20 | 10 | 6.90 | 18.75 | 27.10 | | | 32.00 | 57.1 | 20.2 | 20.2 | |
| 1 | 30 | 10 | 4.85 | 13.00 | 20.55 | 26.2 | | 27.75 | 58.65 | 25.25 | 25.25 | |
| 2 | 60 | 30 | 2.85 | 7.45 | 12.20 | 15.75 | 19.00 | 20.20 | 60.00 | 32.9 | 30 | |
| 3 | 90 | 30 | 1.90 | 5.80 | 9.40 | 12.60 | 15.20 | 16.60 | | 35.3 | 30 | |
| 4 | 120 | 30 | 1.25 | 4.80 | 8.10 | 10.90 | 13.25 | 14.60 | | 35.8 | 30 | |
| 5 | 150 | 30 | .45 | 3.75 | 6.80 | 9.50 | 11.8 | 13.2 | | 35.12 | 30 | |
| 6 | 169.25 | 19.25 | 0 3.83 | 3.20 1 | 6.20 1 | 8.90 1 | 11.1 1 | 12.45 16.80 | | 34.30 34.70 | 30 | |
| 7 | 190 | 20.75 | 5.60 | 1 | 1 | 1 | 1 | 17.90 | | 31.7 | 30 | |
| 8 | 210 | 20 | 7.60 | 1 | 1 | 1 | 1 | 18.40 | | 29.6 | 29.6 | |
| 9 | 240 | 30 | 11.00 | 1 | 1 | 1 | 1 | 20.50 | | 26.1 | 26.1 | |
| 10 | 270 | 30 | 14.60 | 1 | 1 | 1 | 1 | 22.60 | | 22.00 | 22.00 | |
| 11 | 300 | 30 | 17.75 | 1 | 1 | 1 | 1 | 24.65 | | 18.62 | 18.62 | |
| 12 | 330 | 30 | 20.50 | 1 | 1 | 1 | 1 | 26.45 | | 15.8 | 15.80 | |
| 13 | 347 | 17 | 21.90 26.75 | 1 1 | 1 1 | 1 1 | 1 1 | 27.30 31.90 | | 14.60 13.72 | 13.72 | |
| 14 | 360 | 13 | 30.40 | 1 | 1 | 1 | 1 | 34.10 | 1 | 12.65 | 12.65 | |
| 15 | 390 | 30 | 38.55 | 1 | 1 | 1 | 1 | 41.10 | 60.9 | 10.00 | 10.00 | |
| 16 | 420 | 30 | 46.75 | 1 | 1 | 1 | 1 | 48.20 | 67.50 | 6.4 | 6.4 | |
| AP | 450 | 30 | 55.00 | 1 | 1 | 1 | 1 | 55.40 | 75.0 | 2.0 | 2.0 | |

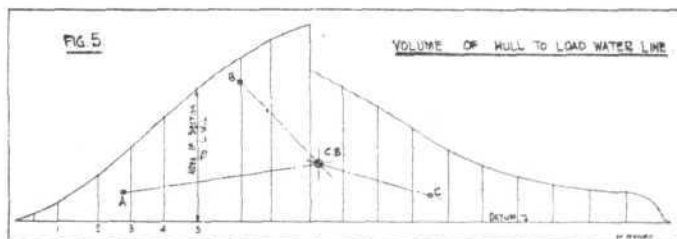
FIG. 3.

W. Munro

used, as indicated in Fig. 4. It is used also on full-scale layout, and, besides ensuring greater accuracy, it also saves a very considerable amount of time in the drawing office and in the shops. For instance, on each frame or bulkhead drawing the buttock offsets can be



omitted and the workman referred to the master curve. This means that only the keel and chine points have to be marked off by him instead of six points or more as is usual when using buttocks. The full-size master curve is made of terne plate of about 16 g.



In Fig. 5 is shown a diagram of displacements to the load water line. Each of the ordinates 1, 2, 3, &c., represents to a convenient scale the area of corresponding sections 1, 2, 3 on the body plan. The volume

THE AIRCRAFT ENGINEER

enclosed by the curve is the displacement to the load water line. The C.B. or centre of buoyancy is determined by cutting out the shape of Fig. 5 from fairly strong cardboard and suspending it freely from each of the points A, B, C in turn. In each case a plumb line is dropped from the point of suspension, and the point where all three plumb lines intersect is the centre of buoyancy. This may appear at first sight to be a rough and ready method, but is, in fact, quite reliable. It will be found in practice that for all working purposes the same result is arrived at by this means as by calculating the displacement to load water line and position of centre of buoyancy by Simpson's rules.

Tank Tests.—In tank tests there are important aspects which have to be neglected, such as the effects of alighting and the behaviour of the machine just at the period of take-off. On the other hand, small differences in the shape of the planing bottom have unexpectedly large results, and tank tests show clearly the best forms to use to minimise resistance and make for clean running. Model float testing without the employment of a wave-making apparatus simulates the worst conditions as regards dynamic stability. Planing stability is improved on water with a moderately roughened surface.

Wing Setting to Hull.—One of the important results of tank tests is to determine the most satisfactory wing setting and trim for any given design. The sum of the angle of incidence, the angle between steps and two degrees allowed for "squatting" by the stern should be two or three degrees below the stalling angle of the wing section chosen.

For commercial machines the take-off is generally considered most important, and the wing setting is arranged to suit this condition.

Take-off.—For the calculations on time to take-off, and length of run to take-off, the factors considered are:—

1. The effective thrust.
2. The water resistance of the hull.
3. The air resistance.
4. The wing area.

Maximum water resistance occurs at approximately 30 per cent. of the take-off speed.

The water drag and air drag are added to give total drag, at all speeds up to take-off speed. On the same graph are plotted the propeller thrust curves. The difference between thrust available and total drag at any speed gives the force available for acceleration, from which the time and take-off can be estimated.

The determination of the lines of the hull, and verification or modification of the same by means of tank tests represents the first stage in the design of the hull. When these lines are considered satisfactory, it is usual to draw them out full scale to fair them, and then the following are investigated, in conjunction with the general arrangement of the machine:—

Hull construction. Strength of hull. Stability of hull.

ON SOLID RIVETS.

By M. LANGLEY, A.M.I.N.A., A.M.I.Ae.E.

Rivets provide one of the best methods of fastening two parts together permanently. They will, however, only carry their load in shear. Any tension on the heads tends to burst them apart, loading them in a way they are ill-fitted to stand.

Fig. 1 shows a use of rivets which is bad. Under strain, the shackle will only be prevented from opening by the stiffness of the material and by pulling against the rivet heads. The result may be as illustrated in Fig. 2.

Had the shackle been designed as in Fig. 3, though not perfect, it would have been much better, and its tendency to straighten out would have been less. This simple and perhaps painfully obvious example serves as an introduction. The more complicated cases of rivet head tension, caused, perhaps, by drumming or vibration of a structure, may not become so obvious until failure occurs, but the possibility should always be present in the designer's mind.

A further example is in the popular single lap (see Fig. 4), which tends to alter to the form shown in Fig. 5. Here the number of rivets, as in a flying-boat hull seam, may be sufficient to ensure that the tension on each is minute. The double strap form of joint completely removes the possibility (Fig. 6).

Many types and shapes of rivets are known to engineering, from the square-headed tap rivet to the big taper-shank pan head rivet. The only two in common use on aircraft structures are the snap head (Fig. 7) and the countersunk (Figs. 8 and 9). The snap head is made in all sizes from 1/16 in. diameter upwards, but the countersunk rivet cannot be used in plates of less than 20 s.w.g., and consequently it is not found in general practice below 1/8 in. diameter.

The standard sizes of heads and the length of shank which must be allowed for forming them are here tabulated.

TABLE 1.

| Snap Head. | | | | | Countersunk Head. | | |
|------------|------|------|------|----------------------|-------------------|------|----------------------|
| Dia. | D. | T. | R. | Length to form head. | D. | T. | Length to form head. |
| in. | in. | in. | in. | in. | in. | in. | in. |
| 1/16 | 0.11 | 0.04 | 0.06 | 0.08 | 0.10 | 0.03 | 0.03 |
| 1/8 | 0.16 | 0.06 | 0.09 | 0.12 | 0.15 | 0.04 | 0.05 |
| 3/16 | 0.22 | 0.08 | 0.12 | 0.16 | 0.20 | 0.05 | 0.06 |
| 1/4 | 0.27 | 0.09 | 0.15 | 0.19 | 0.25 | 0.06 | 0.08 |
| 5/16 | 0.32 | 0.11 | 0.17 | 0.23 | 0.30 | 0.08 | 0.09 |
| 3/8 | 0.44 | 0.15 | 0.23 | 0.31 | 0.40 | 0.10 | 0.13 |
| 7/16 | 0.55 | 0.19 | 0.29 | 0.39 | 0.50 | 0.13 | 0.16 |
| 1/2 | 0.65 | 0.22 | 0.35 | 0.47 | 0.60 | 0.15 | 0.19 |

The "Length to form head" is, of course, the length of shank standing proud of the plate surface when the rivet is inserted in its hole. The total length of rivet required is this dimension plus the thickness of material through which it passes.

The forming and holding-up tools require a certain space bigger than the head diameter, and, when the rivet is used close to the flange of an angle, allowance must be made. Table 2 gives average allowance, but the conditions vary according to the type of tool used.

TABLE 2.

Rivet Shank Dia. Dimension "A."

| In. | In. |
|------|------|
| 1/16 | 0.13 |
| 1/8 | 0.17 |
| 3/16 | 0.21 |
| 1/4 | 0.24 |
| 5/16 | 0.28 |
| 3/8 | 0.36 |
| 7/16 | 0.44 |
| 1/2 | 0.53 |

Rivet Strengths.

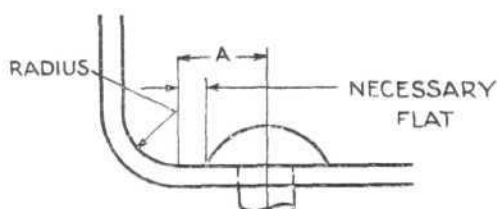
The shear strength of a rivet is given by its cross-sectional area of shank multiplied by the maximum

THE AIRCRAFT ENGINEER

permissible shear stress of the material, i.e., $\frac{\pi \times d^2}{4} \times f_s$.

Its bearing strength in a plate is given by the thickness of plate (t) multiplied by the diameter of the shank (d) and the maximum permissible bearing stress of the material, i.e., $t \times d \times f_b$.

Diagram
for
Table 2.



Assuming that both rivet and plate are of the same or similar materials, we get a relation between these two strengths such that, if made equal, i.e.,

$$\frac{\pi \times d^2}{4} \times f_s = t \times d \times f_b$$

the collapse will be simultaneous. This gives us the most economical size of rivet for any given thickness of plate. In duralumin, taking $f_s = 16$ tons per sq. in. and $f_b = 32$ tons per sq. in.,

$$\begin{aligned} \frac{\pi \times d^2 \times 16}{4} &= t \times d \times 32 \\ 12.56 d^2 &= 32 \cdot t \cdot d \\ 12.56 d &= 32 t \\ d &= 2.55 t \end{aligned}$$

fitting. The appropriate sizes may be tabulated as follows:—

TABLE 3.

| Thickness of Plate. | Diameter of Rivet. | |
|---------------------|-----------------------------|---------------------------|
| | Alum. Alloy and Mild Steel. | Stainless and H.T. Steel. |
| 22 s.w.g. | $\frac{1}{16}$ -in. dia. | $\frac{5}{16}$ -in. |
| 20 " | $\frac{3}{16}$ " " | $\frac{1}{8}$ " " |
| 18 " | $\frac{1}{8}$ " " | $\frac{3}{16}$ " " |
| 16 " | $\frac{5}{16}$ " " | $\frac{7}{16}$ " " |
| 14 " | $\frac{3}{8}$ " " | $\frac{1}{4}$ " " |
| 12 " | $\frac{1}{4}$ " " | $\frac{5}{16}$ " " |
| 10 " | $\frac{5}{16}$ " " | $\frac{1}{2}$ " " |

It will be noticed that thicknesses below 22 s.w.g. have not been considered. Tests have shown* that the relationship breaks down. This is an important point, as a very considerable amount of aircraft riveting is done in structures, such as strip steel spars, which are frequently in thicknesses down to 28 s.w.g. Mr. Radcliffe is led to the conclusion that the bearing strength of the rivet need not be considered in these cases, the criteria of strength being the shear value of the rivet and the bearing and buckling values of the plate. This being so, he concludes that rivets in single shear are

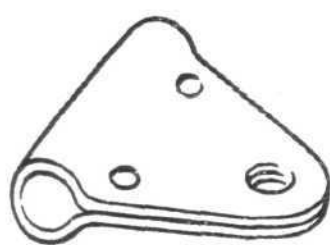


FIG. 1

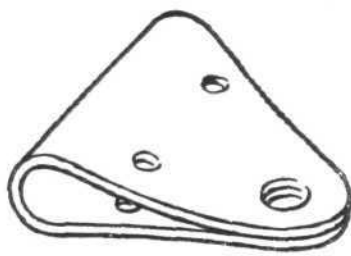


FIG. 2

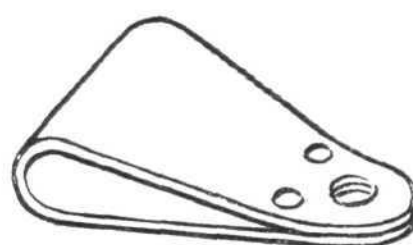


FIG. 3



FIG. 4



FIG. 5

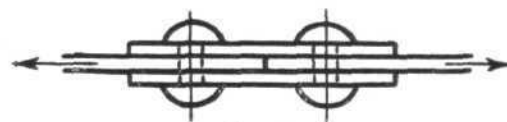


FIG. 6



FIG. 7



FIG. 8



FIG. 9

Similarly in mild steel where $f_s = 18$ tons per sq. in. and $f_b = 38$ " " "

we get $d = 2.69 t$.

In stainless steel rivets (D.T.D. 24A)

$$d = 3.19 t$$

and in high-tensile steel

$$d = 3.18 t$$

From this it appears that the most economical size of rivet is approximately three times the thickness of the plate through which it passes. This ideal condition cannot be observed in practice, particularly where several different thicknesses are used in making up a part or

more efficient than those in double shear. He tabulates a number of tests on both single and double shear joints, which may be of assistance to designers. Until more data are in existence, the strengths of riveted joints in thin materials should be made the subject of tests in all critical cases. Buckling of the material round the rivet is a factor which defies calculation, as it varies according to the local conditions.

The following Strength Tables give the values of the most usual rivet sizes in plate thicknesses from 22 s.w.g. to 8 s.w.g. Extreme cases, such as $1/16$ in. diameter rivet in 10 s.w.g. and $1/4$ in. diameter rivet in 22 s.w.g., have been missed as unlikely to occur in practice.

* See R.Ae.S. Journal, Nov. 1930, Radcliffe, p. 954.

THE AIRCRAFT ENGINEER

In fittings where only one or two rivets are used, these figures should be reduced by 30 per cent.

TABLE 4.
Single Shear Strengths.

| Dia. | Cross Section Area, sq. in. | Alum. Alloy D.T.D. 110 $f_s = 35,850$ lb. per sq. in. | Mild Steel and Stainless Steel D.T.D. 24A $f_s = 40,320$ lb. per sq. in. | H.T. Steel $f_s = 74,000$ lb. per sq. in. |
|----------------|--------------------------------------|--|--|---|
| In. | | Lb. | Lb. | Lb. |
| $\frac{1}{16}$ | 0.0031 | 111 | 125 | 230 |
| $\frac{3}{32}$ | 0.0069 | 247 | 278 | 510 |
| $\frac{1}{8}$ | 0.0123 | 441 | 495 | 910 |
| $\frac{5}{32}$ | 0.0192 | 689 | 775 | 1,420 |
| $\frac{3}{16}$ | 0.0276 | 990 | 1,112 | 2,040 |
| $\frac{1}{4}$ | 0.0491 | 1,760 | 1,975 | 3,630 |
| $\frac{5}{16}$ | 0.0767 | 2,750 | 3,090 | 5,670 |
| $\frac{3}{8}$ | 0.1104 | 3,960 | 4,450 | 8,175 |

Note.—For double shear multiply these values by 2.

TABLE 5.
Bearing Strengths of Rivets in Plates above 0.022-in. (24 s.w.g.).
Aluminium Alloy, Spec. L.3. $f_b = 70,000$ lb. per sq. in.

| Dia. of Rivet. | 22 s.w.g. 0.028 in. | 20 s.w.g. 0.036 in. | 18 s.w.g. 0.048 in. | 16 s.w.g. 0.064 in. | 14 s.w.g. 0.080 in. | 12 s.w.g. 0.104 in. | 10 s.w.g. 0.128 in. | 8 s.w.g. 0.160 in. |
|----------------------|------------------------------|------------------------------|------------------------------|------------------------------|------------------------------|------------------------------|------------------------------|-----------------------------|
| In. | | | | | | | | |
| $\frac{1}{16}$ | 122 | 157 | 210 | Greater | than | double | shear | values |
| $\frac{3}{32}$ | 183 | 236 | 315 | 420 | 700 | 1,137 | 1,682 | 2,800 |
| $\frac{1}{8}$ | 245 | 315 | 420 | 560 | 875 | 1,365 | 2,240 | 3,500 |
| $\frac{5}{32}$ | 307 | 395 | 525 | 700 | 1,050 | 1,682 | 2,800 | 4,200 |
| $\frac{3}{16}$ | 368 | 474 | 630 | 840 | 1,120 | 1,400 | 2,240 | 3,500 |
| $\frac{1}{4}$ | — | 630 | 840 | 1,120 | 1,400 | 1,820 | 2,800 | 4,200 |
| $\frac{5}{16}$ | — | — | 1,050 | 1,400 | 1,750 | 2,275 | 3,360 | 4,200 |
| $\frac{3}{8}$ | — | — | — | 1,660 | 2,100 | 2,730 | 3,360 | 4,200 |

TABLE 6.
Mild Steel, S 3 and Stainless Steel D.T.D. 23^B.
 $f_b = 100,000$ lb.

| Dia. of Rivet. | 22 s.w.g. 0.028 in. | 20 s.w.g. 0.036 in. | 18 s.w.g. 0.048 in. | 16 s.w.g. 0.064 in. | 14 s.w.g. 0.080 in. | 12 s.w.g. 0.104 in. | 10 s.w.g. 0.128 in. | 8 s.w.g. 0.160 in. |
|----------------------|------------------------------|------------------------------|------------------------------|------------------------------|------------------------------|------------------------------|------------------------------|-----------------------------|
| In. | | | | | | | | |
| $\frac{1}{16}$ | 175 | 825 | — | Greater | than | double | shear | values |
| $\frac{3}{32}$ | 262 | 337 | 450 | 800 | 1,000 | 1,950 | 3,200 | 4,000 |
| $\frac{1}{8}$ | 350 | 450 | 600 | 1,000 | 1,250 | 2,600 | 4,000 | 5,000 |
| $\frac{5}{32}$ | 438 | 563 | 750 | 1,000 | 1,250 | 2,600 | 4,000 | 5,000 |
| $\frac{3}{16}$ | 525 | 676 | 900 | 1,200 | 1,500 | 2,600 | 4,000 | 5,000 |
| $\frac{1}{4}$ | — | 900 | 1,200 | 1,600 | 2,000 | 2,600 | 4,000 | 5,000 |
| $\frac{5}{16}$ | — | — | 1,500 | 2,000 | 2,500 | 3,250 | 4,000 | 5,000 |
| $\frac{3}{8}$ | — | — | — | 2,400 | 3,000 | 3,900 | 4,800 | 6,000 |

TABLE 7.
5 per cent. Nickel Steel Sheet, S 4.
 $f_b = 161,000$ lb.

| Dia. of Rivet. | 22 s.w.g. 0.028 in. | 20 s.w.g. 0.036 in. | 18 s.w.g. 0.048 in. | 16 s.w.g. 0.064 in. | 14 s.w.g. 0.080 in. | 12 s.w.g. 0.104 in. | 10 s.w.g. 0.128 in. | 8 s.w.g. 0.160 in. |
|----------------------|------------------------------|------------------------------|------------------------------|------------------------------|------------------------------|------------------------------|------------------------------|-----------------------------|
| In. | | | | | | | | |
| $\frac{1}{16}$ | 282 | 362 | 484 | Greater | than | double | shear | values |
| $\frac{3}{32}$ | 421 | 543 | 725 | 965 | 1,610 | 2,015 | 3,865 | 6,440 |
| $\frac{1}{8}$ | 563 | 724 | 965 | 1,287 | 1,610 | 2,015 | 3,865 | 6,440 |
| $\frac{5}{32}$ | 705 | 906 | 1,208 | 1,610 | 2,015 | 2,620 | 3,865 | 6,440 |
| $\frac{3}{16}$ | 845 | 1,089 | 1,450 | 1,930 | 2,415 | 3,140 | 5,150 | 8,050 |
| $\frac{1}{4}$ | — | 1,448 | 1,930 | 2,580 | 3,220 | 4,180 | 5,150 | 8,050 |
| $\frac{5}{16}$ | — | — | 2,415 | 3,220 | 4,025 | 5,230 | 6,440 | 8,050 |
| $\frac{3}{8}$ | — | — | — | 3,860 | 4,830 | 6,280 | 7,730 | 9,660 |

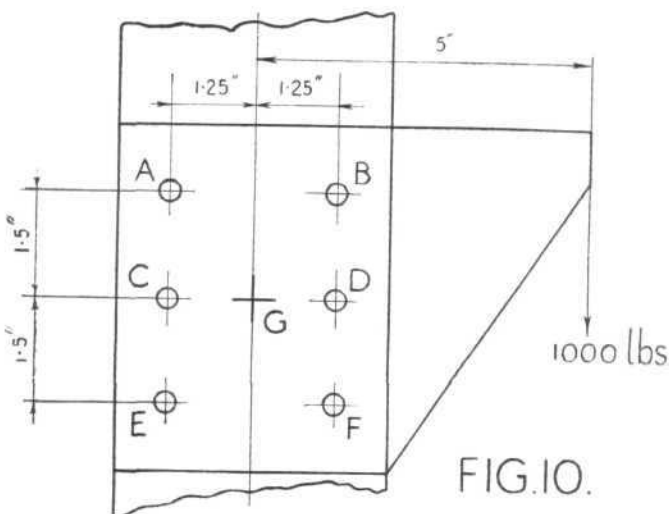
These are the most usual materials for aircraft fittings. Parts made to other specifications may be interpolated. Stainless steel sheet to Spec. D.T.D. 60A is stronger than the material of S.S. rivets to Spec. D.T.D. 24A. Table 6 should, therefore, be used.

Design of Joints.

The design of riveted joints is simple, and is given in most elementary text-books on applied mechanics, such as "Applied Mechanics for Engineers," by Duncan.

The method of stressing a joint where the loading is eccentric is not so frequently explained, yet such joints are very usual on the wing and fuselage structures of aircraft.

Imagine a control pulley standing off a member and supported from it, as shown diagrammatically in Fig. 10. The vertical reaction of control wire load is 1,000 lb., acting parallel to the centre line of the member at a distance of 5 in.



An examination of the diagram shows the centroid of the rivets to be at the point G. There are two states of loading on the rivets:—

- (1) Direct and equal to $\frac{1,000}{6}$ lb. per rivet.
- (2) Resisting the couple, $1,000 \times 5$ lb.-in., in which each rivet takes a load appropriate to its position in relation to G.

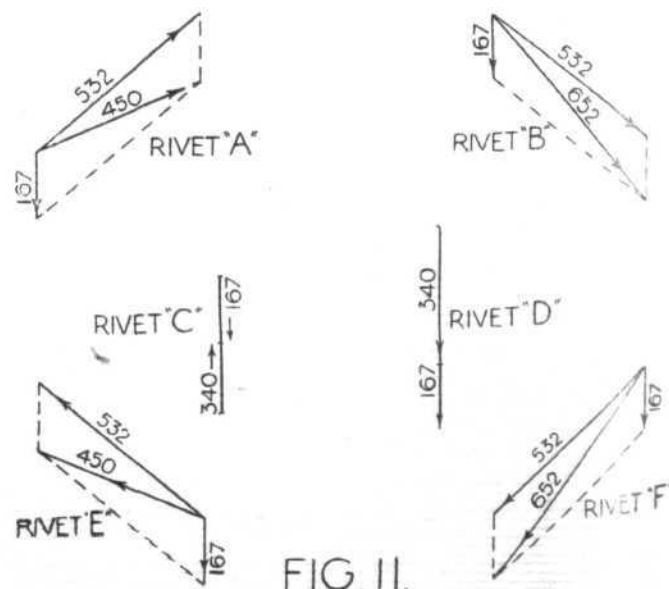
The couple is, in effect, a bending moment resisted by the moment of inertia of the system of rivets, i.e., $\Sigma a y^2$, where "a" is the cross-sectional area of a rivet and "y" its distance from the centroid G.

The distance of rivets A, B, E, F from G is (by Pythagoras)

$$\sqrt{1.5^2 \times 1.25^2} \text{ in.} = \sqrt{2.25 + 1.5625} = \sqrt{3.8125} \text{ in.}$$

and the distances of rivets C and D = 1.25 in. Eliminating "a," we have

$$\begin{aligned} \Sigma y^2 &= (4 \times 3.8125) + (2 \times 1.25^2) \\ &= (4 \times 3.8125) + (2 \times 1.5625) \\ &= 15.25 + 3.125 \\ &= 18.375 \text{ in.}^2 \end{aligned}$$



THE AIRCRAFT ENGINEER

Then the load due to the couple, on the four outer rivets A, B, E, and F, is

$$1,000 \times 5 \text{ lb. in.} \times \frac{\sqrt{3 \cdot 8125 \text{ in.}}}{18 \cdot 378 \text{ in.}^2} \text{ lb.}$$

$$= 532 \text{ lb. each.}$$

And the corresponding load on the two inner rivets C and D is $1,000 \times 5 \text{ lb. in.} \times \frac{1 \cdot 25 \text{ in.}}{18 \cdot 375 \text{ in.}^2} \text{ lb.}$
 $= 340 \text{ lb. each.}$

These loads act at right angles to the lines joining the rivet centres to G respectively. The couple-resisting load on each rivet is then combined with the direct load of $\frac{1,000}{6} \text{ lb.}$ on each, in a parallelogram of forces, as shown in Fig. 11.

The resultant loads on the rivets are:—

| | |
|----------------|---------|
| Rivets A and E | 450 lb. |
| " B " F | 652 lb. |
| " C | 173 lb. |
| " D | 507 lb. |

Spacing of Rivets.

Keel and keelson butts and laps should be treble riveted, whilst shell plate edges, floor plates and frame web laps should be double. In monocoque fuselages, single riveting is usual. When speaking of double and treble riveting, it is assumed that "chain riveting" is meant. "Reeled" riveting is confined to the flanges of angles, channel stiffeners, etc., where the width of material cramps the pitching. The definitions of the above terms will be clear from Fig. 12.

In a small fitting or clip the question of spacing the rivets will be decided by the design of the detail as a whole. In general, however, it may be said that no rivet should be nearer the edge of a plate than twice its diameter, and the minimum distance between rivets should be three diameters.

In metal spars, fuselages, and seaplane floats and hulls, general rules may be laid down to cover most cases. In the long lines of rivets used in these structures a spacing of 8 diameters is usual, except where watertightness is necessary. For hulls and floats a pitch of 4 diameters should be used in all shell seams, attachment of frames and stringers to the shell, and such important structural members as keel and keelson butts, floor plates, etc.

The above ruling of 2 diameters between centre of rivet and edge of plate should be observed, and, where double and treble lines of rivets are used, a spacing of 3 diameters should be allowed between centres of lines.

Where single straps are used on one side of the joint only, they are made of material of the same thickness as the parts they join, or of one gauge thicker. Double straps, one on each side of the joint, are made of the next size above half the thickness of the parts they join.

For large-scale riveting, such as that on flying-boat hulls, Table 3, of appropriate diameters for given thicknesses of material, may be simplified, and is given here, together with lap and strap widths in accordance with the rules just stated.

TABLE 8.

| Thick- ness of Plating. | Dia- meter of Rivet. | Width of Lap. | | | Width of Strap. | | |
|----------------------------------|-------------------------------|---------------|---------|---------|-----------------|---------|---------|
| | | Single. | Double. | Treble. | Single. | Double. | Treble. |
| 14 | in. | in. | in. | in. | in. | in. | in. |
| 16 | 1/4" | 0.75 | 1.35 | 1.90 | 1.50 | 2.65 | 3.75 |
| 18-20 | 3/8" | 0.65 | 1.10 | 1.60 | 1.25 | 2.20 | 3.15 |
| | 1/2" | 0.50 | 0.90 | 1.25 | 1.0 | 1.75 | 2.50 |

Precautions and Workshop Practice.

The effect of hammering up a rivet head is felt not only on the head itself, but also on the plate immediately round the rivet. At each point the plate is stretched very slightly. In long rows this stretching becomes quite appreciable, and sufficient to cause "wind" in a spar or built-up strut. On a hull or fuselage it will cockle the plate along the length of the lap. The trouble can be prevented. A spar should be bolted up with service bolts at every fourth hole along all its flanges before the first rivet is put in. The rivets should then be inserted in the intermediate holes, starting from the ends and middle simultaneously in all flanges. Similarly in a hull or fuselage, the plate should be bolted in position at every fourth hole, and the riveting should not "grow" round the edge from one point alone. The more it is spread about within practical limits the better. If the lap is arranged near a longitudinal stringer, the stiffness of this will prevent undue cockling and the resultant drumming of the plate. A similar precaution is to swage the plate edges (Fig. 13). In fuselages and metal-covered wings, where

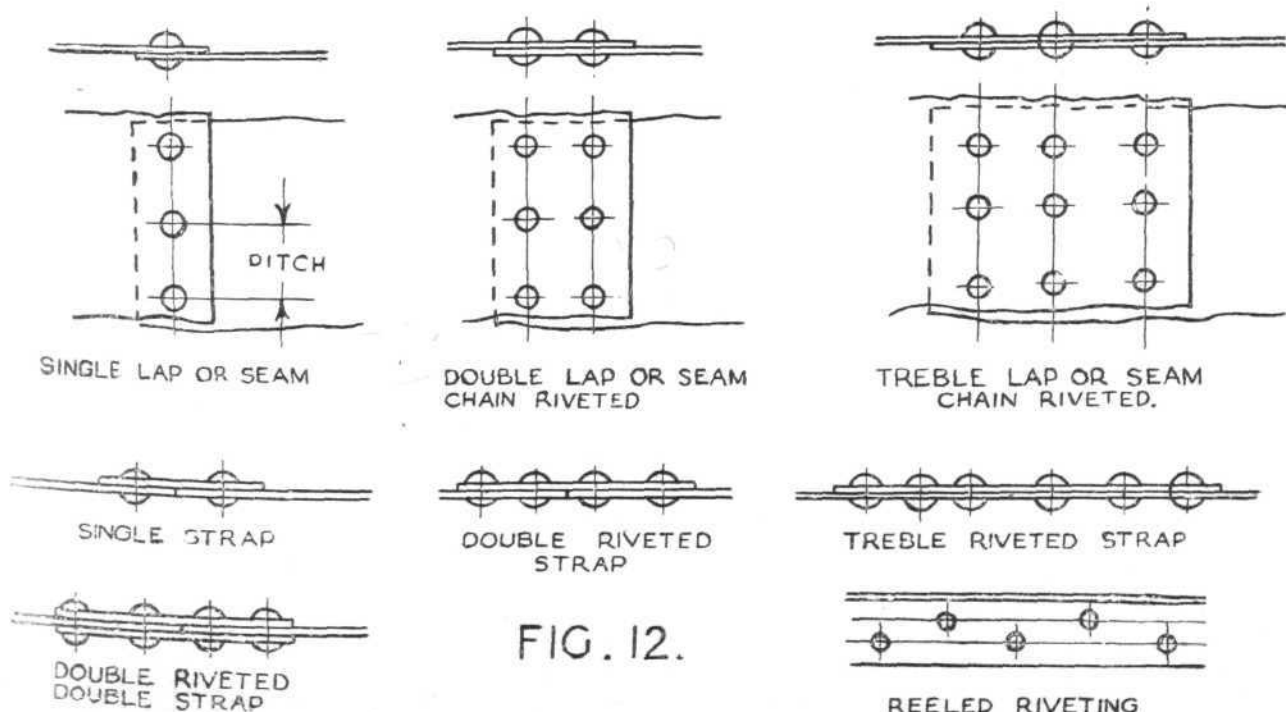


FIG. 12.

THE AIRCRAFT ENGINEER

the covering is corrugated, this, of course, occurs automatically.

The question of badly-formed rivet heads is frequently raised by inspectors, who are countered by "knowing" foremen claiming that, since rivets are only used in



FIG. 13

shear, the head shape is immaterial. Whilst this is to some extent true, it does not go the whole way. A half-formed head (Fig. 14) indicates that inefficient or insufficient hammering has been applied to it, with the result that the shank of the rivet is not properly expanded and pressed home into its hole. A single rivet in a long row badly formed may not be of importance, but one should suspect the joint if there are several thus.



FIG. 14

Hand riveting is expensive and often unsatisfactory. There is more possibility of damage to the surrounding plate, and the heads are frequently poor. Pneumatic riveting is satisfactory when carefully carried out. The tool is of the kind used in shipyards for light caulking. But the best workmanship is obtained from a single pressure machine, such as was illustrated in *FLIGHT* (*THE AIRCRAFT ENGINEER*), October 25, 1928, page 936. This implies bench work, and is suitable for spars, fuselage formers and hull frames. It cannot be used in attaching skin plating to internal structure, although there are cases where large panels of plating may be put together before erection.

Aluminium-alloy rivets should not be used in the annealed condition. Not only will they never develop their full strength, but they are liable to induce corrosion in the surrounding plate. The usual procedure is to anodically coat them first and to follow this by full heat treatment to $480^{\circ}\text{C.} \pm 10$, and quenching. If used within an hour, they are soft and pliable, and will age-harden to their full strength later.

It is argued that in hull and seaplane work the rivet heads are the corrosion danger points, particularly as the hammered-up ends cannot have an anodic surface. A method of overcoming this fault, which is employed by Messrs. Saunders Roe, Ltd., is to hammer up on the inside of the hull, at least up to the waterline. This is only possible on hulls with an extremely accessible internal structure, and there are some points where it cannot be done. The principle may be applied in riveting together panels of shell plating before erection.

Whilst the obstruction to the air flow caused by the rivets may be comparatively small on large machines, it becomes of importance on the fuselages and main planes of small fast craft. In such aeroplanes the skin is usually too thin to allow of countersinking, and a satisfactory solution has yet to be found. Where the skin is supported by a robust member, this may be countersunk and the skin forced down into the hollow, causing in effect a countersink on the outer surface. But it is only a partial solution. Elsewhere the heads may be made flat instead of domed, a process difficult to carry out without cracking the edge of the rivet head. The aircraft industry awaits a really neat method of achieving a smooth surface to a thin riveted shell.

TECHNICAL LITERATURE

SUMMARIES OF AERONAUTICAL RESEARCH COMMITTEE REPORTS

These Reports are published by His Majesty's Stationery Office, London, and may be purchased directly from H.M. Stationery Office at the following addresses: Adastral House, Kingsway, W.C.2; 120, George Street, Edinburgh; York Street, Manchester; 1, St. Andrew's Crescent, Cardiff; 15, Donegall Square West, Belfast; or through any bookseller.

FURTHER EXPERIMENTS ON THE BEHAVIOUR OF SINGLE CRYSTALS OF ZINC SUBJECTED TO ALTERNATING TORSIONAL STRESSES. By H. J. Gough, M.B.E., D.Sc., and H. L. Cox, B.A. Work performed for the Department of Scientific and Industrial Research. R. & M. No. 1322 (M. 68). (20 pages and 9 diagrams.) August, 1929. Price 1s. 6d. net.

These experiments form part of a lengthy investigation into the theory of fatigue and relate mainly to experiments on single crystals of various metals. From the results of a previous experiment* on a single crystal of zinc, it was concluded that the formation of twins in zinc occurred on planes of the 1012 type and that the particular operative twinning plane (of the six available) was determined chiefly by the direction of slip on the original basal plane and possibly, to some extent, by the relative magnitudes of the normal stresses on the possible twinning planes. In this previous experiment the orientation of the crystal was such that slip on the original basal plane occurred in one direction only and one pair of complementary twins only was observed.

From the results it was predicted that if a test were made on a crystal of suitable relative orientation of the crystallographic and straining axes such that all three slip directions became operative then the operative twinning planes should change with the slip direction. The present experiment was planned in order to test this prediction. Again, in the previous experiment, of the two possible pairs of complementary twinning planes associated with any one slip direction, it appeared probable that the choice of the operative pair was influenced by considerations of normal stress on the twinning plane. The present experiment would, it was hoped, throw further light on this aspect of twinning.

The slip plane of zinc is the basal plane (0001); the slip direction is the most highly stressed primitive direction; deformation by slip is controlled by the criterion of maximum resolved shear stress. The twinning planes of zinc are the six planes of the general type 1012.

With the specimens employed in the present tests, due to the relative orientation of crystallographic and straining axes, and to the type of applied stressing, three slip directions become operative in turn. The results show definitely: (a) One pair only of complementary twinning planes appear in the area associated with each operative slip direction, thus reducing the total of six possible twinning planes to three pairs; (b) a change in slip direction is accompanied by a change in the identity of the pair of operative twinning planes; (c) in any operative slip direction, the twinning planes containing that slip direction do not appear; (d) normal stress alone does not determine the choice of operative twinning plane. If conditions (a), (b), (c) and (d) are fulfilled, only one sequence of operative twinning planes can result, offering two alternative phases of the sequence. Both phases have been observed on different specimens.

The important conclusion is thus reached that the occurrence of twins, as well as slip bands, is controlled by the simple criterion of maximum resolved shear stress on the slip plane.

* "Roy. Soc. Proc.," A. vol. 123, pp. 143-167 (1929) and R. & M. No. 1183.

† Associated with the initial structure of the unstressed crystal.

AIRSCREWS FOR HIGH SPEED AEROPLANES. By H. Glauert, M.A. Communicated by the Director of Scientific Research, Air Ministry. R. & M. No. 1342 (Ac. 474). (18 pages and 7 diagrams.) June, 1930. Price 1s. net.

Since little is known of the characteristics of an airscrew at the high rates of advance which occur with modern racing aeroplanes, it is desirable to examine theoretically the most suitable type of airscrew for modern and future high speed aeroplanes, to determine the efficiency of these airscrews, and to consider the possibility of improving the low static thrust which usually accompanies a high pitch-diameter ratio.

Adopting a few simplifying assumptions, the characteristics of a series of high pitch airscrews have been calculated, and these results have been used to establish a relationship between the pitch-diameter ratio, torque coefficient and solidity of an airscrew operating near the state of maximum efficiency. Another approximate formula has been derived for the efficiency of the airscrew, and these formulae have been used to determine the most suitable type of airscrew for a high-speed aeroplane. A simple formula has also been derived for the static thrust of a high pitch airscrew.

The analysis suggests that the tip speed of the airscrew may be limited to the moderate value of 900 f.p.s. and, using a suitable gear ratio, an efficiency of over 80 per cent. may then be anticipated. For a modern racing aeroplane of the most suitable type is one with two blades of diameter 10 ft. and it is necessary to use a gear ratio of the order of 0.6, but as the speed of the aeroplane increases the need of a gear ratio will disappear and the most suitable airscrew will be one of smaller diameter with a larger number of blades. The relatively poor static thrust is an inevitable consequence of the high speed of the aeroplane, being directly proportional to the power of the engine and inversely proportional to the speed of the aeroplane, irrespective of the diameter of the airscrew or of the gear ratio; the only hope of improvement is to use a variable pitch airscrew.

PRIVATE FLYING & CLUB NEWS

NORTHAMPTON

THE annual pageant of the Northamptonshire Aero Club was held at Sywell on Monday last.

In the old days one used religiously to give a list of all the pilots and machines which turned up, but now, since both pilots and machines have multiplied in numbers, and since the number of machines attending a meeting has increased from a mere handful up to anything in the region of a hundred, it is quite impossible in the space which we are able to devote, to give a full list. Time was when the fuel and oil companies possessed only one machine each, and when the number of private owners was very small, but now that several of these firms have three machines each, and the number of private owners is many hundreds, a mere catalogue of those present at each meeting would become dull and uninteresting, hence the omission of such a catalogue on this occasion.

At Sywell, as always, the spirit which reigned was one of quiet efficiency and exceptional enthusiasm, and the number of aerial visitors was very large indeed.

We were glad to see the Brothers Linnell once more in charge of the flying organisation, and very ably did they carry it out. There were no hitches and everything went perfectly smoothly. Arrangements both in the club enclosures and in the large field allotted to the general public were admirable, and everyone must have enjoyed themselves thoroughly.

The programme itself, this year included a greater number of comic turns, a feature which we think is altogether praiseworthy since a constant repetition of aerobatics by different pilots can become boring after a time.

It was unfortunate that Mrs. Victor Bruce was unable to perform the opening ceremony owing to an attack of influenza, but Lord Erskine ably stepped into the breach, and, in a voice which must surely have been trained by the B.B.C., broadcast a fitting speech for the occasion.

At the start there was a parade of a large number of different machines, including the Autogiro, Moths, Avians, Puss Moths, Bluebird, Parnell Pixie, Spartan, Lincock, Westland Wessex and Desoutter. After the parade several of these were given a few minutes in the air by way of individual demonstration.

The comic turns took the form of a cowboy, who from the cockpit of a Moth supposedly shot several of a string of balloons which were anchored to a cord well out on the aerodrome. After a few failures, some three or four were certainly burst. If the shooting was actually done from the cockpit we would like to congratulate the marksman, but we have a strong suspicion that nefarious means were used, though quite how was difficult to see since there was nobody anywhere near the target! Sometime later a local machine called the "Sywlider," which it was announced was the production of the Wilby Aircraft Co., was given its first flight by means of a tow from a motor car. It was a weird and wonderful machine, somewhat on the lines of Mr. Lowe Wylde's productions, but suitably modified to suit Sywell needs! The pilot in the cockpit, from the way he lolled about and

almost fell overboard, gave the impression that the hospitality he had received from the club the evening before had been almost too much for him. However, every effort was made to assist him, even to the length of attaching several balloons to his head in an endeavour to keep his heated brow up into the cool air. The "Sywlider" rose extremely well to a height of about 30 ft., but unfortunately then proceeded to crash. With due promptitude the ambulance was on the spot, and several figures danced around the wreckage. The body was hauled from the remains of the cockpit, but unfortunately two over-zealous members each seemed to want to take it in a different direction, with the result that it was dismembered and the sawdust spilled on the surface of the aerodrome!

Flt.-Lt. Schofield put up an excellent show on an Autogiro, and Mr. Lowe Wylde made several flights on his latest two-seater sailplane. The star turn was undoubtedly the "wizardly" exhibition of F/O. W. E. P. Johnson. This year he was flying a Lincock, which had been fitted for inverted flying. No description of the way in which he handled his machine could be adequate, and it must suffice to say that it appeared to make no difference to him whether he was inverted or the right way up. Sometime later he also bombed a tank, and after several near shots succeeded in destroying it. The final explosion wrecked the vehicle sadly, and revealed a strangely familiar chassis which we hope will live to perform a similar function

next year, for Sywell without that contraption would not be Sywell! The club's instructor, Mr. E. F. Palmer, broadcast a demonstration of flying from a club Moth, and explained his various manoeuvres as he did them. The parachute descent which was to have taken place could not be performed owing to the high wind.

The success of a show like this depends very largely upon the co-operation of all club members, who naturally do their best to assist in every way. It would be impossible to mention all these, whether they were stewards who helped to park the machines or the attractive young ladies who supplied all visitors with tickets and invitations to the dance which was to be held the same evening, but one case we think deserves special mention, and that was Mr. Bruce Olney, who did all the broadcasting, and enabled the general public to get such a good idea of what was going on. Let us hope that although flying meetings may in general become fewer in number, Sywell will continue to become a "better and better" annual entertainment.

The Illingworth Cup, for the best display of flying, was awarded to F/O. Johnson, and the Sywell Grand National, a race round a triangular course was won by Mr. W. Gairdner (Puss Moth), who looks after Brian Lewis and C. D. Barnard's interests at Hooton, with Mr. F. Gough (Moth) second and Mr. N. Brett (Avian) third.

The A.A. aviation staff deserve praise for efficient way they controlled and assisted in parking the aircraft, a task of no small magnitude, as there were some 60 aircraft present and these divided into three parks.



Lord Erskine declares the Meeting open. Mr. Bruce Olney, the "announcer," is on the right.



The wreck of the "Sywlider" and dismemberment of its pilot. The local V.A.D. must have been disappointed!

BROOKLANDS.—Another figure well known in aviation circles has joined Brooklands Aviation, Ltd. This is Mr. S. A. Thorn, who was for some time test pilot of Cirrus Aero Engines, Ltd. Mr. Thorn's piloting is extremely well known by virtue of the magnificent stunts which he invariably puts up when demonstrating a machine, or when giving exhibitions at air meetings, and there is no doubt that he will make a most competent instructor. He also possesses that peculiarly likeable personality which is an indispensable part of the make-up of a successful flying instructor, though no doubt he will find the work somewhat different to test flying.

During the last week four new pupils joined the school in one day, and the general club facilities have been so much to the liking of members that there is already a long waiting list for bedroom accommodation in the new buildings. In an endeavour to cope with this demand, arrangements have been made with the lessee of the old bungalows to provide some further accommodation.

Exceptionally bad weather during the week cut down the number of flying hours to 40. Two pilots, Messrs. Lo and Willis, were sent off solo, while Mr. J. Chapman completed the cross-country flights necessary for his "B" licence. Several machines of those which have been overhauled for their C's. of A. have been delivered, and these newly-painted machines continue to maintain a spring-like air about the workshops.

At the air display on June 6 there will be a considerable number of machines in a special park available for inspection, including the Autogiro, Avian, Bluebird, Moth, Puss Moth, Spartan, Wessex and Vickers Vialra. It is also hoped that a demonstration will be given of one or more of the very fastest single-seater Service aircraft. Mr. Lowe-Wylde will be giving a further demonstration of his two-seater sailplane, by means of auto towing, and Mr. Raymond Quilter will make a parachute drop. One of the most interesting items of the whole display will be a competition for private owners, marks being awarded for the best-kept aeroplane. In order to make this as fair as possible, entries will be divided into three classes, and all private owners wishing to enter should get into touch with the authorities as soon as possible. This strikes us as being a particularly sensible form of competition, for it is generally safe to say that a well-kept machine means a safe machine, and also shows that the owner is in all probability a safe pilot, because one who takes the trouble to look after his machine well usually takes the trouble to learn to fly well. Private owners who are visiting the display are particularly asked to arrive before lunch, when transport will be arranged for them from the paddock to the aerodrome. As a further attraction to private owners who are members of light aeroplane clubs, all such will, on production of their membership tickets, be invited to become honorary members of the Brooklands Aero Club for the rest of the season. This is an extremely sporting offer, and one which should have far-reaching effects in making the club popular.

In the interests of safety, it has been decided to close the aerodrome entirely, between 3 p.m. and 6 p.m., and

all pilots are asked to make note of this fact and to avoid landing between these times. Such a regulation is not one which can be enforced, and can only be carried out by appealing directly to those concerned; and in view of the fact that these meetings are presenting a traffic problem which is increasing very rapidly indeed, we sincerely hope that pilots of visiting aircraft will help the management by abiding by their wishes.

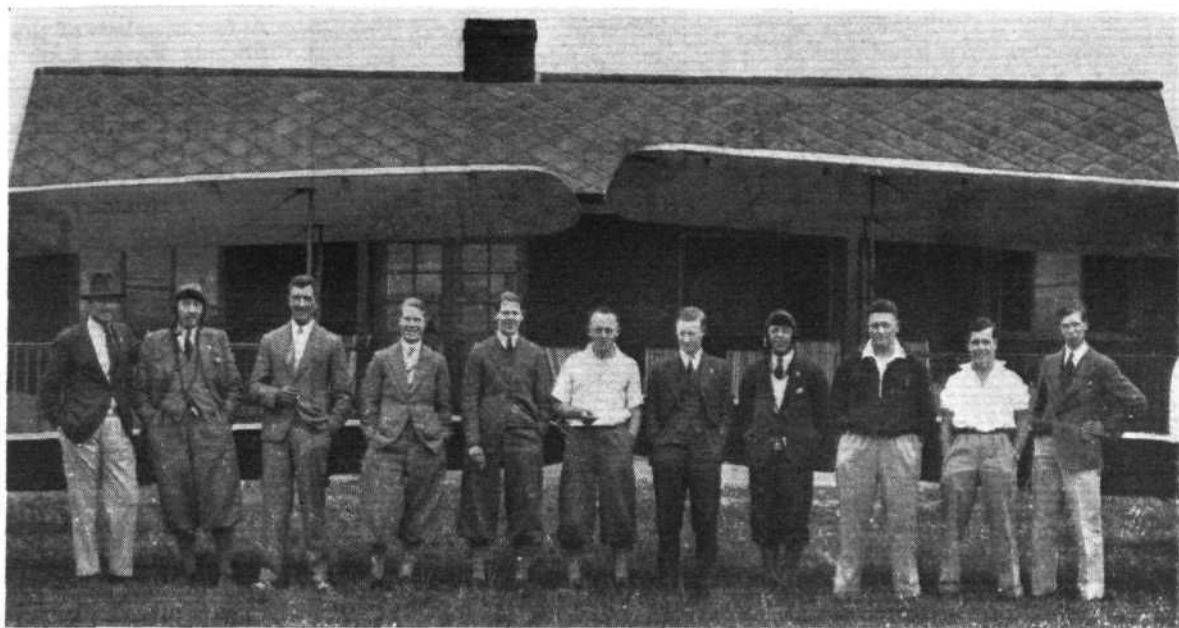
Visitors should not fail to have a look at the model of the new club house and control tower which is on exhibition in the paddock building.

The voucher coupon which has been published in *FLIGHT* for the last two weeks, enabling holders to obtain a shilling reduction on their entrance fee to the meeting, will appear for the last time next week.

THE MANCHESTER-LIVERPOOL RACE.—The Manchester-Liverpool Inter-city Race has been arranged to take place on Saturday, August 15. The first machine will leave Barton at 3 p.m., and, after a turn round Southport pier, will make another turn at Roby and land at Hooton Aerodrome. Here there will be a compulsory stop of one hour, after which the course will lay round another turning point at Woodford Aerodrome, and so back to Barton. The Southport Aero Club will look after the arrangements at Southport and the Lancashire Aero Club those at Woodford. During the stay at Hooton, all arrangements will be in charge of the Liverpool Aero Club. It is expected that competitors should cross the finishing line at Barton about 4.45 p.m. During the time between the start and finish, Northern Air Lines are arranging a display to be held at Barton to entertain the spectators.

MEETINGS IN THE NORTH.—There will be a meeting at Sherburn-in-Elmet on Sunday, May 31, and one at Hedon Aerodrome on Sunday, June 7. Both these are being run by National Flying Services through their clubs, the Yorkshire Aeroplane Club and the Hull Aeroplane Club, at Sherburn-in-Elmet. At Sherburn there will be a 30-mile race for the Yorkshire Cup, which has been presented by Lord Grimthorpe, and Capt. Blake will demonstrate the Blackburn Lincock. Mr. S. A. Thorn will give the first demonstration of the "Arrow Active." At Hedon, Mr. George Murray will give a demonstration of inverted flying, and the Civilian Coupé, which has already created so much interest, will be shown. At both these meetings it is hoped that F/O. P. M. Watt will give an aerobatic display on the Martlet, and Flt.-Lt. C. S. Staniland a display on the Fairey "Firefly."

A PAGEANT AT CAMBRIDGE.—Marshalls' Flying School will be holding a pageant at Cambridge during May Week, on Saturday, June 13. The programme will be continual and concentrated between 2 p.m. and 5.30 p.m. There will also be a race for past and present members of both the Oxford and Cambridge Universities, for which a challenge bowl has been presented. Those wishing to take part in this should apply to the Secretary, Mr. E. H. Freshfield, Trinity College, Cambridge.



The Hertfordshire and Essex Aero Club of Broxbourne which numbers several well-known "dirt-track" riders amongst its members.

GOOD ORGANISATION.—The Nottingham Flying Club show, which should have been held on Sunday, was postponed owing to the weather, and was held on Tuesday, May 26. It was fortunate for the club that Tuesday is also held as a Whitsun holiday in the district, for the result was that they were able to obtain a very big crowd.

Quite a large number of pilots actually arrived on Sunday in spite of the bad weather, and before his departure that afternoon for Scarborough, Mr. George Murray gave an impromptu aerobatic display, which was without exception one of the very finest we have ever seen. He certainly is a magnificent pilot at inverted flying, and his tight inverted turns, inverted falling leaf, spins and double bunts are a joy to behold.

The postponed show, when held on Tuesday, was a triumph of organisation, and the too-often-spoken-about anti-N.F.S. feeling, which has unfortunately been obvious in the past, does now definitely seem to have been laid low.

Everyone enjoyed themselves at Nottingham. The programme went absolutely smoothly, with no waits, and the arrangements made for the comfort of all were of the very best. Sir Harold Bowden, President of the Club, opened the meeting by a speech broadcast from the van, kindly lent by Mr. Lindsay Everard. This van is an exceptionally fine outfit for the work, and, if necessary, can be heard even up to two miles away with perfect clarity. During the show, Mr. E. C. Brown, W. B. Dick & Co.'s representative, did the broadcasting in his usual skilful manner.

The programme consisted of aerobatic displays by F/O. W. E. P. Johnson, on the Lincok, and F/O. H. H. Leech on the Martlet, Spartan Arrow, and Civilian Coupé, all of which were, of course, extremely good, the names of the pilots being sufficient criterion for their excellence. Mr. Leech, on the Spartan, was particularly interesting, because this display was not so much an aerobatic one as a demonstration of the exceptional flying capabilities of this aircraft. He showed its amazing control at slow speeds, and certainly gave the impression that it must be one of the safest machines flying, an impression which we may say is fully justified.

There was also an aerobatic competition for "A" licence pilots of the Notts, Leicester, Derby, and Lincoln clubs, for which a cup was given by the *Nottingham Journal*. This consisted of a climb to 1,500 ft., a loop, a flick roll, a half-roll, and, finally, a landing on the circle. The judges were Col. Sempill and Mr. Jeffs, and the winners were Mr. Winn, first; Mr. Lovesey, second; and Mr. Sall, third; all on Moths.

The reliability race, details of which were announced last week over 100-mile course, was won by Flt.-Lt. D. S. Green, with $\frac{1}{2}$ -min. error, in an Avian, with Major Allen, 1-min. error, second, in a Puss Moth, and Mr. T. Bradford, 7-min. error, third, in a Moth.

Capt. G. W. Stewart carried out his parachute jump with an Irvin air chute, and landed beautifully, by means of a judicious side-slip, right in front of the enclosure. Readers will know that we do not agree with parachutes being used for such shows, but this does not in any way detract from Capt. Stewart's excellent judgment.

At the finish of the show, prizes were given by Lady Bowden. Taken all round, everyone admitted that the Nottingham Show was excellently run from every point of view, and undoubtedly did a very great deal to popularise flying in the district and to place N.F.S. on a footing with those who "can do things well."

SCARBOROUGH.—The newly-formed club at Scarborough rather let themselves down on Whit Monday, and the officials would do well to study the organisation of shows given by other clubs before they attempt another one. We understand that arrangements for the visitors, and also of the actual programme, were lamentably weak in many ways.

There were some 20 machines present and a crowd of over 8,000 people, but the club members who were acting as stewards apparently preferred sight-seeing to assisting, and the three police who were there to deal with the crowd were naturally overwhelmed.

Reports of such an event naturally vary somewhat, but the consensus of opinion would appear to indicate that all arrangements were distinctly poor. This is a very great pity, because Scarborough has distinct possibilities as a club; the location is excellent and the amenities of the neighbourhood attractive. We sincerely hope that all concerned will have learnt from their mistakes and that they will make a better show next time.

The Lord Mayor opened the show, and the Lady Mayoress, Mrs. Butler, performed the baptismal ceremony on the club's first machine, a Redwing, after which Mr. H. H. Leech flew it in a demonstration. There was a race for a cup presented by the Scarborough Townsmen's Association, over a course of some 40 miles, and the handicapping was well up to the usual style of Messrs. Dancy and Rowarth. The winner was Mr. H. H. Leech, at a speed of 103½ m.p.h., on the Martlet (Genet II); Mr. George Murray second at 104 m.p.h. on his Moth; and Capt. Percival third at 104½ m.p.h. on his Hendy 302; very few seconds covering the winners.

Other items included Mr. J. D. Irving in a comic "Capt. Nevamiss" sort of show; Capt. C. B. Wilson on the Avian (Hermes II); Mr. Field, who bombed a car in an inverted Moth, using salvoes of bombs instead of the usual single shots; Flt.-Lt. Russell on the Redwing; and Mr. George Murray in one of his magnificent aerobatic displays on his Moth.

Mr. E. C. Brown was naturally doing the broadcasting, while Mr. Jeffs, whom, we understand, has, as a result of his trip up from Croydon that morning, vowed never again to fly after a breakfast of fat bacon, was in charge of the flying control.



A few members of the Household Brigade Flying Club (L. to R.): Mr. R. L. Preston (Coldstream Guards), Mrs. Fairlee, Mrs. Harrison, Mr. Grey Sykes (Scots Guards, R. of A.), Mrs. Grey Sykes, Mr. Harrison (Grenadier Guards).

(FLIGHT Photo.)

THE YUGOSLAV MEETING.—During the Whitsun week-end quite a large British contingent visited the meeting held at Zagreb, in Yugoslavia. Among those present were Col. Shelmerdine, Mr. Lindsay Everard, Mr. W. D. Macpherson, Miss Spooner, Mr. Jackaman, Flt.-Lt. Armour, and Flt.-Lt. Watt. During the meeting there was a 200-km. race, with Major Grabischnik first and Miss Spooner second. The prize for all-round efficiency was won by Flt.-Lt. Watt, while Mr. Jackaman won the prize for landing on a given point.

arrow near to it shows true north, thus giving the pilot a very good idea of the direction of the wind. This type of indicator is very much more useful than the ordinary wind-stocking type, since it indicates the wind at exactly the place where the pilot is going to land, and not, as is so often the case, at the side of the aerodrome, in the proximity of buildings. This also makes it much easier for pilots, who are naturally looking at the circle when going to land, and do not, therefore, have to search round to find the wind stocking.

A FINE GLIDE.—On Sunday, Major Petre made what, if it has been observed, is a British gliding duration record, by a magnificent flight of 3 hr. 28 min. 5 sec. He was flying a "Professor" type sailplane at Totternhoe Beacon, the gliding ground of the London Gliding Club, and the flight was made in spite of the fact that the wind was by no means ideal, while rain fell heavily for a great deal of the time. The previous record was, of course, that of 3 hr. 21 min. 7 sec., set up by the late M. Maneyrol at Itford, in Sussex, in 1922. Major Petre is, of course, one of the earliest British pilots, and took his original flying certificate in November, 1911, after which he acted as an inspector to the Air Force of the Commonwealth of Australia.

On the preceding Saturday, Miss Susia Lippens, daughter of the Belgian Minister of Transport, also made what is probably the record flight for women in this country, by remaining in the air for 1 hr. 2 min. This was done at Balls Dene, near Brighton.

Herr Kronfeld, who was also over on a holiday, tried out the Scud, and found it an excellent soaring glider.

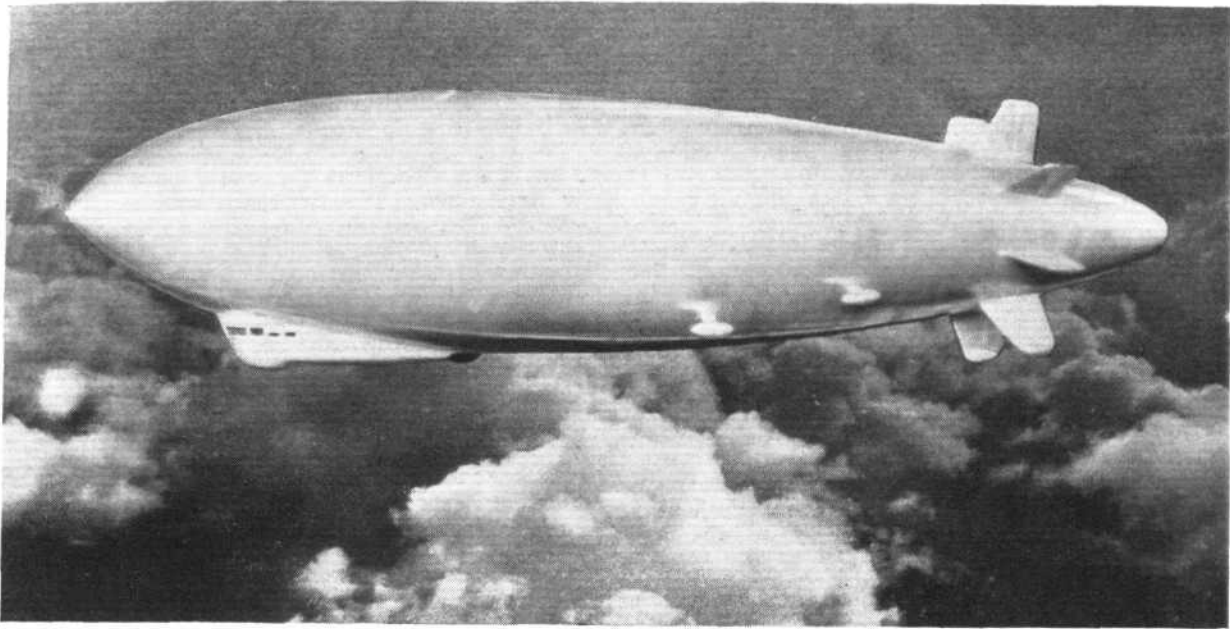
NEW GLIDING CLUBS.—Two new gliding clubs are in the process of formation, one at Selkirk and the other at Windermere. That at Selkirk has been formed largely through the agency of Lieut.-Commander Steedman,

Ravensheugh, Selkirk, while that at Windermere through Mr. Cooper Pattinson, Beresford Road, Windermere. Anyone interested in the formation of these clubs, and wishing to know more about them, should get into touch with these gentlemen at the above address.

THE SAILPLANE CLUB.—The Sailplane Club, which is the gliding section of The Model Aeroplane Club, had a very enjoyable Whitsun meeting at Smalldole. Quite a large number of excellent flights were made, and many members are now ready to take their "A" licences. The Bramble Castle Hotel has become the local headquarters, and visitors and members are asked to note that a United Service motor coach now runs every Sunday from Victoria to the hotel, which is only a short walk from the ground. The day return ticket costs 5s., or 7s. 6d. for a period return.



Mr. and Mrs. Nigel Norman at Heston, together with their "little pilots." (FLIGHT Photo.)



The proposed 100-ton, 100 m.p.h. Metalclad Airship as she will appear when finished.

THE METALCLAD AIRSHIP

By CARL B. FRITSCHÉ

[The paper has perforce been greatly abridged. The full paper will, however, appear in due course, in the Journal of the Royal Aeronautical Society.—ED.]

(Concluded from p. 464)

Intercrystalline Corrosion

RETURNING to the specific subject of corrosion. The alclad covering of the ZMC-2 is now almost three years old. Superficially the exterior of the hull appears less bright in lustre, due to a film of oxide on the pure aluminium coating. The interior, being in direct contact with helium, of course, is relatively free from oxidation and has the same mirror-like brilliance that characterised the metal when new.

Last December (1930) four plates, 10 in. by 12 in., were cut from the hull for test, the holes being closed with hand-riveted metal patches. These plates were submitted to the Bureau of Standards for examination metallographically for evidences of corrosion.

Seven specimens with transverse and longitudinal fibres cut from these plates were tested according to the method prescribed in the "U.S. Navy Specifications for Aluminium Alloy Sheet." The average results obtained are summarised in Table VII, and are compared with the original design and manufacturer's specifications.

PHYSICAL PROPERTIES ZMC-2 0-0095 ALCLAD SHEET

| | Specification guaranteed by manufacturer | Design specifications | Bureau Standards Test—1931. |
|---|--|-----------------------|-----------------------------|
| Ultimate tensile strength, lb./in. ² | 50,000 | 50,000 | 56,300 |
| Yield point, lb./in. ² | 27,000 | 28,000 | 37,400 |
| Elongation in 2 in. per cent. | 13 | 12 | 17.4 |

The results of these tests justify confidence in the metal. In every respect its properties still exceed design specifications by a very comfortable margin. There is evidently no loss in ultimate tensile strength, and very little loss indicated in elongation. Random and unofficial tests of new metal made in 1928, prior to assembly, indicated a yield point as high as 42,700 lb./in.² and an elongation of 18 per cent. in 2 in. Certainly, with an average elongation of 17.4 per cent., there is no evidence of an attack from intercrystalline corrosion.

Of all the sheet specimens examined microscopically at 500 times magnification, none showed pits due to corrosion deeper than 0.003 in. In no case did the surface attack appear to have penetrated through the aluminium coating, which ranges from 0.005 to 0.007 in. in thickness.

With the experience available to date, the sponsors of the metalclad feel no hesitancy in predicting a life for a commercial ship of at least eight to ten years, in so far as corrosion of the hull is concerned.

With respect to fatigue of the metal plating and seams from vibration and snap diaphragm action, it is pointed out that in the operation of the ZMC-2 no snap diaphragm action has been observed. In view of the ability of the plating to withstand vibration satisfactorily, as determined by laboratory tests, and the absence of such vibration under actual operating conditions, it is safely predicted that there need be no alarm from this cause.

The ZMC-2 has now been in operation for 21 months as a training ship, and no change in its structure has been found necessary, or desirable, except the substitution of a balloon tyre landing wheel under the car in place of the oleo tube bumper. It has flown over 500 hours, and its operating record shows a diffusion of helium at the rate of about one-half that of fabric ships of similar size. Therefore, it is believed that in larger ships the diffusion would compare favourably with that of new goldbeater skin without any substantial increase with age, due to the absence in the metalclad of the wear and tear and more rapid deterioration which handicaps goldbeater skin.

Pressure in Airships*

Lighter-than-air craft whose shape is maintained solely by internal pressure are often called "Pressure Airships." In these, contraction and expansion of gas is compensated for by ballonets. The internal pressure is maintained by blowing air in the ballonets. The air pressure acts on the ballonet diaphragm, increasing the pressure in the gas container and producing tension in the outer cover.

This tension is considered as composed of two components: longitudinal, acting in the direction of the ship's axis; and transverse (or hoop) tension, acting in the plane perpendicular to it. The transverse component retains the shape of cross section. The longitudinal component maintains the longitudinal shape of an airship. When the airship is built of materials that cannot resist compression loads, this longitudinal component should be such that the tension due to it exceeds the compression imposed by either static or aerodynamic loads acting on the hull. This consideration determines the internal pressure used in the hull.

It may appear that the internal pressure should be of considerable magnitude, but, due to the large cross sectional areas, the pressure in the case of non-rigid air-

* By W. A. Klikoff.

ships is in general about $1\frac{1}{2}$ in. H_2O . This can easily be maintained mechanically, but is also easily subjected to atmospheric variations.

This small pressure corresponds to only $2^\circ F.$ change in temperature and 0.11 in. of Hg. change in pressure, or 100 ft. change in altitude. This comparison shows the sensitiveness of pressure to outside atmospheric conditions and the necessity for careful handling.

Maintenance of Pressure

Excess pressure is handled by automatic valves which are designed for maximum rate of ascent and set so that air valves open first and the gas valves follow, preserving gas as much as possible. Manual control of the valve is also provided.

In non-rigids the pressure is maintained by scoops lowered manually in the slipstream. The drop in pressure to or below atmospheric will cause the collapse of envelope and the necessity of abandoning the forward speed. The maintenance of too high a pressure produces high tensions in the envelope, causing rapid deterioration.

The semi-rigid airship was evolved to relieve tension load in the fabric, and this is achieved by introducing a rigid keel for carrying a high percentage of the bending load.

The opinion is often expressed that rigid airships are independent of pressure. This opinion is erroneous, because the rigid airships are not, and a series of openings are provided to keep internal pressure as close as possible to atmospheric. Some of the rigid airships tend to utilise the effect of pressure for the support of fabric. For instance, the R.101 was normally operated under slight positive pressure to reduce flapping of fabric covering, and openings in the envelope to satisfy these conditions were provided.

Pressure as a Design Factor

The pressure within a gas container increases upward due to the difference of the densities of air and gas. This property is called "gas head," and is similar to "water head," but of an opposite sign.

If we call h the head of gas measured upward, and k the unit lift of gas, the pressure due to gas head becomes kh .

This pressure produces constant longitudinal force which in case of fully inflated circular airship is $K\pi r^2 h$ where r is the radius of cross section.

The pressure due to gas head increases toward the top of the airship, therefore the resultant of this longitudinal force acts above the centre line, which usually coincides with the neutral axis of the airship. Consequently it will tend to produce a hogging bending moment, which for fully inflated ship is equal to $k\pi r^3 h/4$.

Whereas in non-rigids the transverse component of pressure produces uniform transverse tension in the covering, in rigid airships this transverse component acts as a side load on longitudinals, complicating their design by loading them with side load combined with direct stresses due to bending of the whole airship. This loading condition of longitudinals tends to explain why gas pressure is often called a liability in the case of conventional rigid airships.

The diameter of modern airships has already reached 132 ft. In this case the pressure due to gas head at the top of the hull at the maximum section becomes for a helium filled ship:

$$820 \text{ lb. per sq. ft. or } 1.57 \text{ in. } H_2O.$$

The total longitudinal force becomes 57,000 lb. and the hogging moment 950,000 ft.-lb.

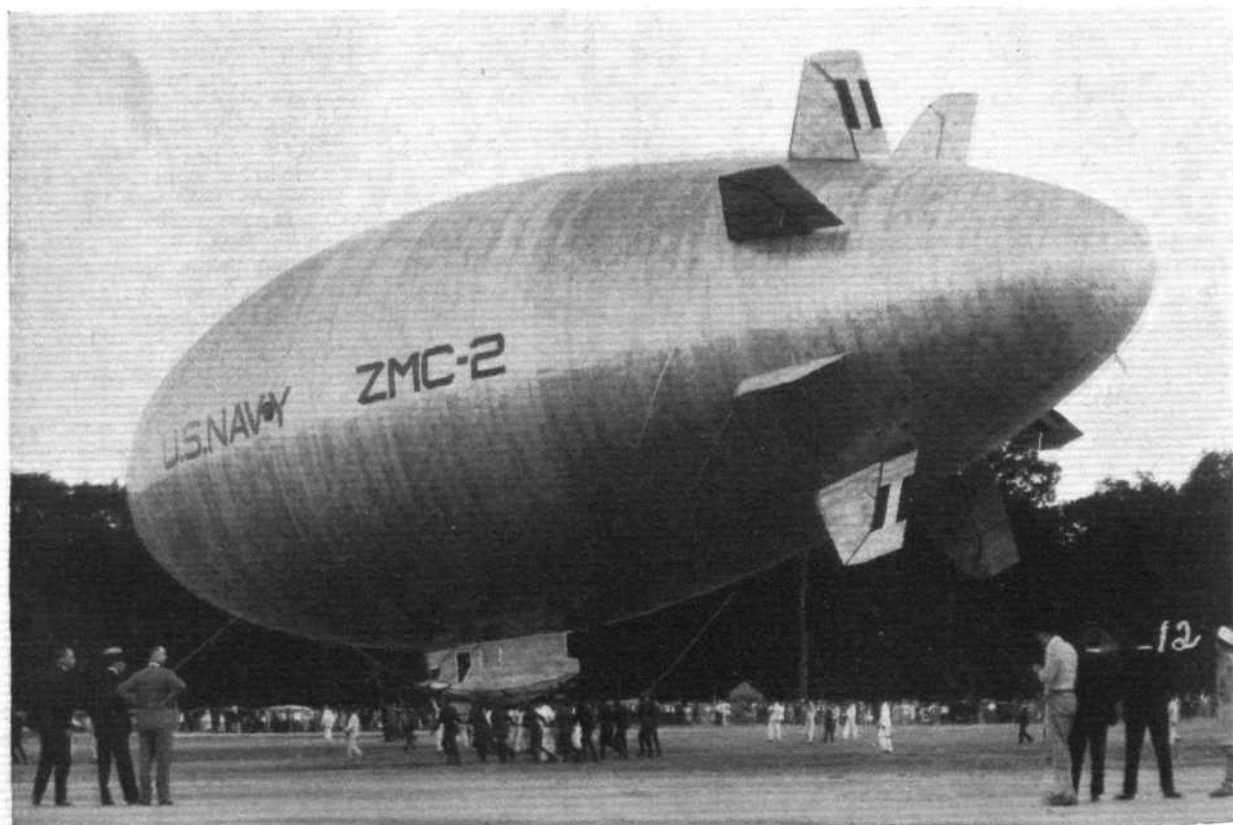
These gas head pressures produce forces and moments of such magnitudes that the designer should utilise them to his advantage. The longitudinal force is the most helpful because it tends to produce a uniform tension throughout the structure, and all materials used in airships can carry higher tensile loads than compression loads. It is of interest to study the help derived from the longitudinal tension on the hull.

In an airship whose cross-sectional area of metal used is A , which is distributed uniformly around the cross section, the moment of inertia of this cross section is $Ar^2/2$, and if this airship is subjected to a longitudinal force P and bending moment M , then the maximum compressive longitudinal stress will equal $S = P/A - 2M/Ar^2$.

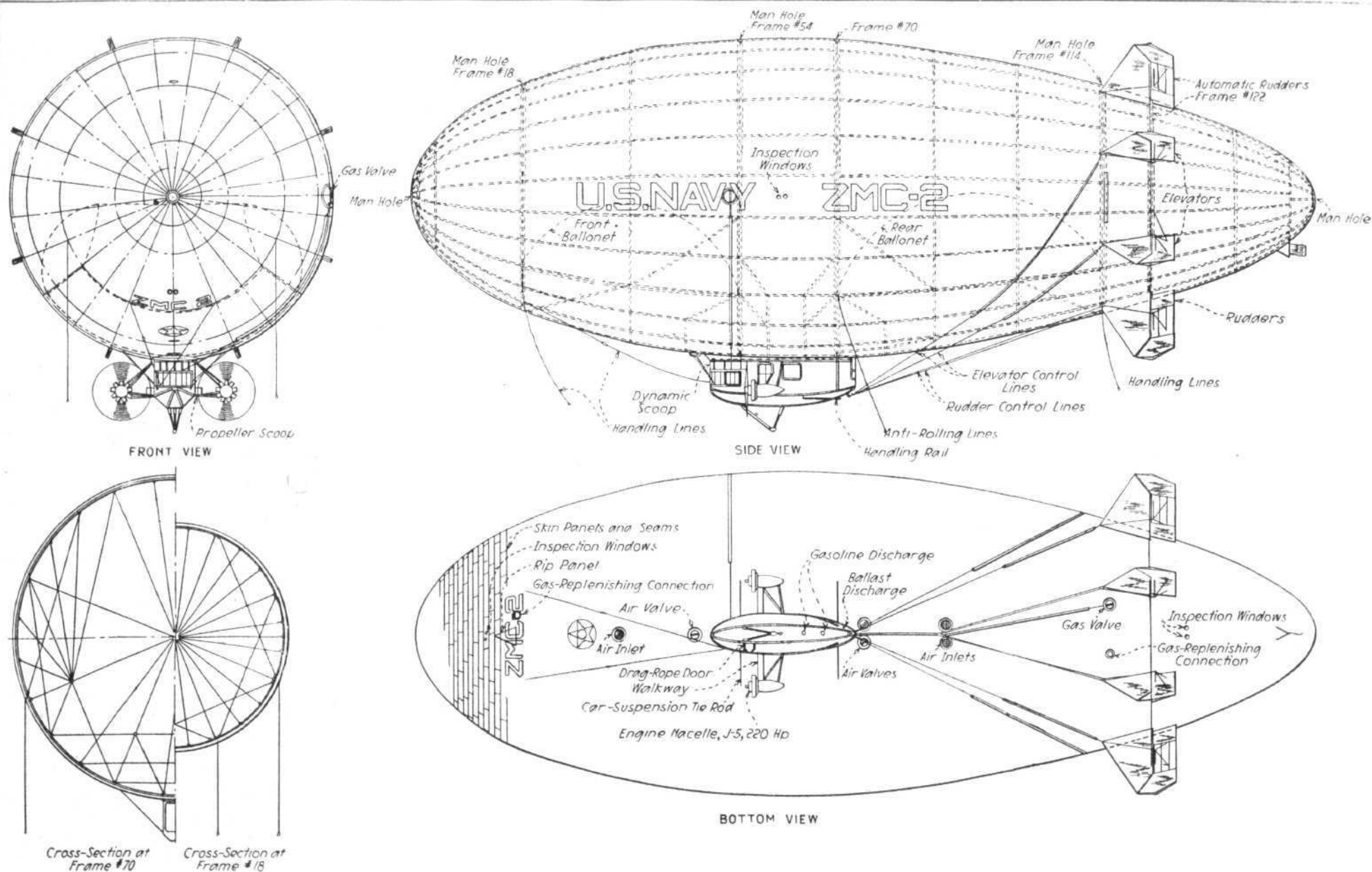
Assuming, as in the case of the non-rigid, the outer covering incapable of carrying any compressive loads or limiting the value of stress, $S = 0$, then solving the above equation we obtain the critical value of bending moment in relation to longitudinal force $M/P = r/2$. If the non-rigid airship is full of gas and is subjected to pressure due to gas head only, then the relation of gas pressure bending moment to longitudinal force due to gas pressure

$$M/P = kr^4/4kr^3 = r/4;$$

or the value of hogging bending moment can be doubled before compressive loads will occur in the fabric, and the



The ZMC.2 just before her first trial flight on August 19, 1929. The crew were Capt. W. E. Kepner, Carl B. Fritsche, E. J. Hill, A. G. Schlosser, I. Bishop. The duration of the flight was 49 min. 55 sec.



A general arrangement drawing of the ZMC.2 showing the control system.

airship could carry sagging bending moment equal to three times the gas pressure moment without having any longitudinal folds in the fabric.

Introducing internal pressure higher than the pressure due to gas head, such rigidity of hull can be obtained that very severe mending moments can be carried by the hull, which is exactly the practice followed in non-rigid airships.

Take the case of the British airship R.101.

This airship was 732 ft. long, 132 ft. in dia., and had an air displacement equal to 5,600,000 cu. ft. The arbitrary value of the maximum aerodynamic bending moment to which this size of airship would be subjected is

$$M = 0.02 (\rho/2) V^2 (\text{Vol})^{2/3} L$$

or at 75 m.p.h. at sea level,

$$M = 0.0000237 \times 110^2 \times$$

$$31,000 \times 732 = 6,640,000 \text{ ft. lb.}$$

Assuming that gas pressure bending moment resists all the static loads, then to counterbalance the effect of this aerodynamic bending moment the longitudinal force due to internal air pressure should be $P = P\pi r^2 = 2M/r$; and internal pressure

$$P = (6,640,000 \times 2) / (3.14 \times 663) =$$

$$14.7 \text{ lb./sq. ft.} = 2.82 \text{ in. H}_2\text{O.}$$

By increasing internal pressure only 180 per cent. above the pressure which is present on top of the ship, due to gas head, all the compressive stresses which would appear in the hull due to the action of this severe aerodynamic bending moment will be eliminated. This computation does not mean that all the stresses will be eliminated, they will appear on the tension side; but as long as material used for present airships are of such properties that they can resist tension from 50 to 100 per cent. better than compression, the advantage of utilising the internal pressure can be seen.

Design Condition and Factors of Safety

Factors of safety of 4 and higher are used for static loads, but when the aerodynamic loads are superimposed the designers do not increase the structure in proportion to increase of load, but increase the structural strength only to some extent which causes decreasing of the factors of safety. This method of design may make the operating personnel over-confident in the strength of airships, and in emergency they may treat the airship without due caution, causing perhaps a breakage of structure and severe disaster.

The nature and magnitude of gusts and other aerodynamic forces are not completely known, and will probably never be definitely known.

A more logical system of design would be to design an airship for instances of the following conditions:—

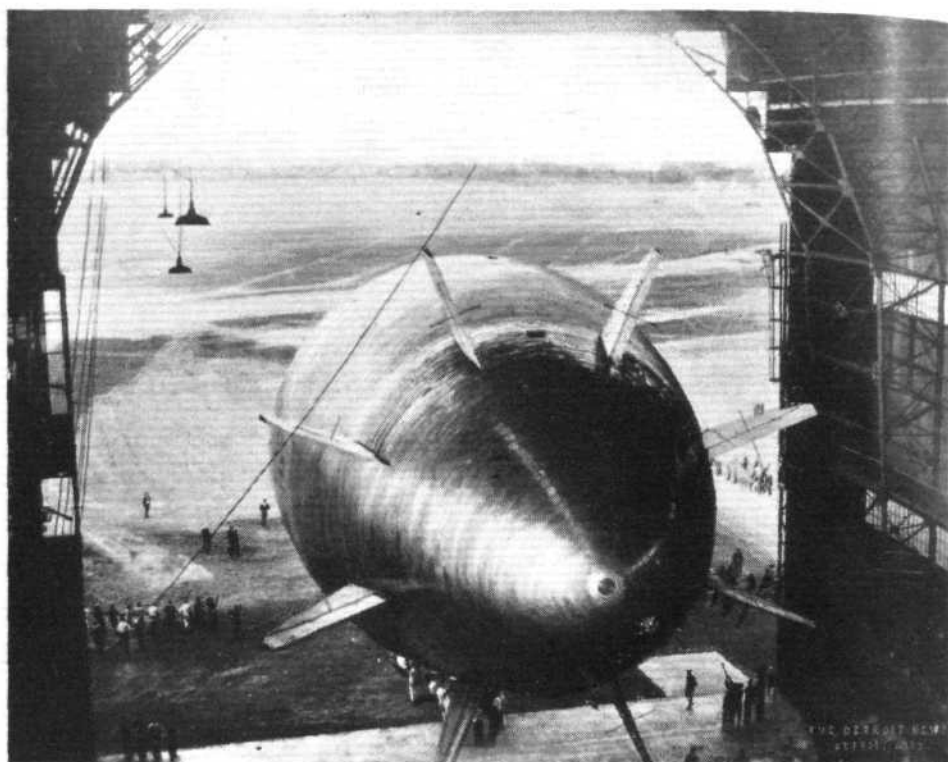
1. Adopt a reasonable factor of safety for the worst static conditions, combined with certain usually encounterable aerodynamic loads.
2. Provide enough compressive strength in the airship to be able to carry these loads safely.
3. In flight when the airship is subjected to severe aerodynamic loads, provide the excess strength and maintain the same factors of safety by introducing certain other positive factors of strength, for instance, pressure.

The operating personnel will then know that when the airship is operating under internal pressure the compressive strength is not endangered.

When the pressure system is not functioning, then he knows that the airship is not strong enough to withstand severe loads, and should be handled carefully.

Pressure Rigid Airships

As was mentioned previously, conventional pressure airships are so dependent on the pressure that a drop in



The ZMC.2 leaving her shed. This view gives a good idea of the unique fin arrangement.

pressure means a loss of shape and inability to proceed at a forward speed, thus transferring the airship to the free balloon class.

The condition is undesirable, and it should be the aim of designers of pressure airships to design the airships in such a manner that they can maintain their shape and proceed at slow speeds at atmospheric internal pressure, using the internal pressure as auxiliary means of extra strength and rigidity in case of flying at high speeds.

The question arises as to the possibility of controlling the internal pressure. All the disadvantages of the pressure supply system as used in present airships can be eliminated if designers follow the mechanical engineer, who has already solved the problem of pressure control in power plant installations.

Several automatic pressure regulators could be installed, such that a drop of internal pressure would cause immediate opening of propeller scoops, in case of flight under power, or would start the blower motor, and, in case of failure of the pressure system, would switch off some of the engines, reducing the speed to a point safely allowable for operation without pressure.

The regulators would take care of variation of pressure by operating pressure-supplying units. These units could be connected to the control car, and any change in their position would be shown by a signal on the board in the car. Thus all elements of the internal pressure control system could be checked by releasing the pressure and observing their functioning through the signals.

Proposed Pressure Control in Metalclad Airships

The body of the airship should be made air-tight. This can be attained by providing doors which are pressure-tight. Some of the crew and passenger quarters, and means of access to the structure, can be placed in the hull in the air space, which, under certain conditions, will be under slight pressure. This can also easily be achieved, and the small internal pressure of, say, 3 in. water, will not be uncomfortable.

If the pressure rises above the design value, then an excess of it will be released by the air valves.

The main pressure-supplying units will be the scoops, located at points where the external dynamic pressure due to forward motion will exceed the internal pressure.

In case of descents under power, when a large quantity of air must be supplied, the propeller scoops located in the slipstream of the propeller can be used. It is proposed to control these scoops by automatic pressure regulators. If the air supplied by the dynamic scoops is insufficient, the

pressure inside of the hull will drop, and the automatic pressure regulators will open the propeller scoops.

Mechanical blowers should be installed to supply air for rapid descent without forward speed, and for ground handling. The blowers will be controlled by the automatic regulators, which will start them when the system of dynamic and propeller scoops may prove to be inadequate.

Manual control of all the pressure control items can be provided as an auxiliary.

Types of Airship Structures

It would appear that the most efficient system of design should utilise the compressive and tensile ability of the cross section to the utmost advantage. The most advan-

tageous value of internal pressure will be such that the factors of safety on the compression and tension side are equal, or 5.5 for the loading above mentioned.

The ultimate metalclad airship design would try to approach these requirements. In it the high transverse stresses due to pressure, which are so detrimental to fabric non-rigids, are carried by monocoque metal covering. The hull of such a ship would also be reinforced in the longitudinal direction to carry appreciable compressive loads. The perfection of this method of construction employing the proper combination of internal structure with stressed skin covering will produce the very efficient large size airship capable of the high speed essential to commercial application.

AIRISMS FROM THE FOUR WINDS

The Prince Flies to Southampton

ON May 27 the Prince of Wales flew from London to Southampton in order to inspect the Canadian Pacific Co.'s steamship *Empress of Britain* before she sails to Quebec on her maiden voyage. The Prince christened and launched the new liner from the Clydebank shipbuilding yard of Messrs. John Brown & Co. on June 12 last year.

London-Copenhagen-London in a Day

FLYING the Vickers-Napier biplane which he intends to use for his attempt to lower the record for a flight to Australia and back, Captain T. Neville Stack, accompanied by Mr. J. R. Chaplin, established something of a record on May 23 by leaving Heston Air Park, London, in the morning, arriving at Copenhagen about midday, and returning back to Heston in the evening. The distance to Copenhagen by the route followed (Calais-Rotterdam-Hamburg) is roughly 700 miles. The actual flying time was just over 11 hours, so that the average speed was about 124 m.p.h. The weather was good on the outward journey, and on the return journey as far as Calais, but from there to Heston heavy rains were encountered. Both the Vickers machine and the Napier engine behaved well, and no mechanical trouble of any sort was experienced.

Flight-Lieut. Scott Returning Home

FLIGHT-LIEUTENANT SCOTT—who recently established the England to Australia air record—left Wyndham early on May 26 on his return flight.

Hawks' High-Speed Hops

ON May 21, Capt. Frank Hawks flew in his Travel Air "Texaco 13" from Malmö, Sweden, to Paris, about 720 miles, in 3 hr. 15 min., at a speed of over 215 m.p.h. It is reported that Capt. Hawks is planning shortly to breakfast in London, lunch in Berlin, and dine in Paris!

DO-X and DO-X II

THE German flying boat DO-X, which left Germany six months ago on a flight to South America, is still at Bolama, Portuguese Guinea, unable to get off the water with its load; some of the crew have returned to Ger-

many. The second Dornier DO-X flying boat, which was ordered from Italy, has now been completed, and made a first successful test flight over Lake Constance on May 23. The DO-X II is fitted with twelve 600-h.p. Fiat engines.

Vincennes Meeting

THE annual two-day meeting at Vincennes opened on May 24, under the Presidency of M. Doumergue. We hope to publish a report of this meeting next week.

British Airwomen Honoured

LADY BAILEY and Miss Amy Johnson were presented, in Paris on May 23, with medals and diplomas of honour of the International League of Aviators.

Inquest on Lt.-Commander Kidston

THE Chairman of the inquest on Lit.-Commander Glen Kidston and Captain T. A. Gladstone, who were killed when their "Puss Moth" crashed on May 5, found that they "died from multiple injuries sustained in an aeroplane accident on the Tantesberg." The inquiry (as distinct from the inquest) was adjourned *sine die* at the instance of a representative of the makers of the machine to enable expert evidence to be obtained, if necessary, from England, on certain points raised in the course of the inquiry.

An Air Ambulance Scheme

AT a meeting of the V.A.D. Council held on May 19, proposals were discussed for the formation of Ambulance Aeroplane Detachments. The British Red Cross Society is contemplating their formation, and flying clubs have promised to support the scheme. The society has been presented with a Desoutter cabin aeroplane, and the alterations necessary to fit it up as an ambulance are in hand.

The Royal Tournament

WE go to press on the eve of the opening of the Royal Tournament at Olympia, and are unable to give our impressions of the performance. This year the trick-riding display is being given by the 14/20 Hussars, and the musical drive by "J" Battery, R.H.A. The historical pageant falls to the lot of the Gloucestershire Regiment, the wearers of the famous "back badge." An unusual

feature is the display by the Signals' despatch riders on motor cycles. Piping and Highland dancing is in the hands of the London Scottish (Territorial Army). The Royal Air Force again gives a display of physical training, which is always a beautiful and very popular show; but, of course, the third service reserves its best efforts for its own display at Hendon on June 27. The Royal Tournament is always one of the most enjoyable events of the London season, and those who patronise it have the satisfaction of knowing that their money goes to help Service charities. The Tournament runs from May 28 to June 13.



A POLISH AMPHIBIAN: The Pulawski "P.Z.L." amphibian flying boat, manufactured by Panstwowe Zaklady Lotnicze, in Poland. It is fitted with a D.H. "Gipsy III" engine, installed as a pusher. As such the engine has proved perfectly satisfactory, and the machine performs remarkably well.

"Puss Moths" for Czecho-Slovakia

A "REPEAT order" has been received by the De Havilland Aircraft Co. Ltd., for the supply of two further "Puss Moth" cabin aeroplanes to Mr. Thomas Bata, "the uncrowned shoe-king of Europe," who virtually owns the town of Zlin, Czecho-Slovakia, where his gigantic factory turns out 100,000 pairs of boots and shoes every day. Until last year, Mr. Bata operated a fleet of out-of-date German machines, which he now proposes to replace entirely with British aircraft. His two new Puss Moths are to be provided with navigation lighting and flare equipment, which suggests that night flying is to be indulged in to enable his executives to cover his big market. Mr. Bata's heart is very much in civil flying, and he states that his own use of the fast and economical type of plane is doing much to encourage private ownership.

A Metal Construction "Pool"

We understand that an important step has recently been taken by three well-known British aircraft firms in the form of a pooling of the three firms' patents covering metal construction of aircraft. The firms in question are Armstrong-Whitworth, Boulton & Paul, and the Gloster Aircraft Co., Ltd. Between them these three firms hold patents covering nearly every imaginable form of metal construction, and in the future any one of the three firms will be at liberty to use forms of construction covered by patents held by one or other of the other two. It seems likely that a not inconsiderable number of other firms in the British aircraft industry will be faced with the obligation to make some arrangement, either in the form of royalties or otherwise, with the new company, and it is to be hoped, in the interests of the industry generally, that the demands made will not be excessive.

Handley Page Slots and the Guggenheim Competition

At the annual general meeting of Handley Page, Ltd., on May 21, it was announced by the chairman (Mr. S. R. Worley) that the proceedings instituted by the company against the Curtiss company for infringement of patent by using slots on the machine which won first prize in the Guggenheim safety competition had been settled by agreement. The American company had agreed to a consent decree of the United States court whereby they acknowledged their infringement and also acknowledged the validity of the Handley Page patents. The American company had also entered into a royalty agreement with the Handley Page firm so that any machines to which they might attach slots in the future would pay royalty.

U.S.A. Air Demonstration

The 1st Air Division of the U.S. Army Air Corps, consisting of 600 to 700 aeroplanes of various classes, recently gave demonstrations of American air strength by flying in formation, first over Chicago and, a few days later, over New York. While the formation was crossing over New York, one machine, which had a Press photographer as passenger, was obliged to land from engine trouble. The pilot brought the machine down in shallow water near the harbour, and both pilot and passenger were picked up unharmed. The state of the passenger's camera and plates is not reported. Meantime, pacifist organisations held meetings of protest in the streets.

Screening a City with Smoke

MARSHAL PÉTAIN recently witnessed an interesting experiment in protecting a village near Lille from air attack by creating a thick cloud of smoke or mist, which speedily covered the village, and rendered it invisible from the air. The fog is described as quite harmless to those whom it enveloped, though they suffered from slight irritation of the nose and throat. Small local smoke screens are an old device, but this attempt at a widespread screen is an interesting novelty, which may lead to a greater degree of protection for inhabited areas in time of war.

Mr. Shackleton returning to England

His many friends will be glad to learn that Mr. W. S. Shackleton is shortly returning to England from Australia, whither he went some years ago on account of indifferent health. Mr. Shackleton, who will, perhaps, be best remembered as the designer of the little A.N.E.C. monoplane, and later the Beardmore "Wee Bee," has now wholly regained his health, and on his return to the "Old Country" he will, in conjunction with Mr. Lee Murray, who is generally regarded as one of the soundest pilots in Australia, establish a business as consulting engineer, chiefly in connection with advising on the suitability and purchase of aircraft from England by Australian, New Zealand and New Guinea operating companies or private individuals. Mr. Shackleton has been chief designer and

engineer to the Larkin Aircraft Supply Company. Shackleton and Murray have between them a very thorough practical knowledge of Australian conditions, and they should be very successful in attaining their ideal of developing a reliable and unbiased liaison between aeronautical interests at home and in the Southern Hemisphere. Promises of support have already been received from Australia, New Guinea and New Zealand. Mr. Shackleton and his family are travelling home by boat, while Mr. Lee Murray is flying his Desoutter monoplane across Canada and the United States to study conditions there. Mr. Shackleton hopes to reach England early in June, and communications sent to him at Devonshire House, Addlestone, Surrey, will find him.

Death of Sir Trevor Dawson

We regret to announce the death, on May 19, of Commander Sir Arthur Trevor Dawson, Bt., Director of Vickers and Vickers-Armstrong, Ltd., and chairman or director of several allied companies. Sir Trevor was well known in the iron and steel industry, particularly in the building of warships and the manufacture of guns. He retired from the Royal Navy in 1896, to become Superintendent of Ordnance to Vickers, Sons & Maxim, Ltd., and later became chairman of Vicker's Artillery and Shipbuilding Management Board.

Wartime Airmen to Fly over London

THE South London Branch of the Comrades of the Royal Air Forces are to visit Croydon aerodrome on Sunday, May 31, at 3.30 p.m., when they will be shown around the airport, etc., and then ascend for a flight over London. Arrangements have been made with Imperial Airways for a party of about 200 to share this flight.

Aero Golfing Society

THE Spring Meeting of the Aero Golfing Society for the Challenge Cup presented by the proprietors of FLIGHT, was held at Walton Heath on Tuesday, May 19, 1931. The winner was Brian Lewis, 84 - 11 = 73.

T.M.A.C. at Stag Lane

We understand that the Directors of the De Havilland Aircraft Co., Ltd., have given facilities to The Model Aircraft Club for the formation of the 3rd Wing, Squadrons 7-8-9, at Stag Lane, for D.H. Students, under Capt. Eden.

New Spanish Airport.

SPAIN added a new airport to those already in existence in that country when, on May 1, an aerodrome was officially opened at Barajas, near Madrid.

A Modern Shop

NATIONAL Flying Services, Ltd., have opened in Northumberland Avenue a shop where everything associated with flying will be sold. The shop, designed by Mr. Raymond McGrath, decoration consultant to the B.B.C., has been prepared to appeal to the general public. Its walls and ceiling are curved to represent the cabin of an aircraft. Its counter is in the form of an aeroplane wing. There are a latticed tower and an artificial wind "stocking" in the window, and many aeroplane models are hung in prominent positions. This shop will also sell tickets for journeys by air on air lines, pleasure trips, and taxi services. We would suggest that a more attractive exterior might bring great numbers of people to appreciate the interior.



A Modern Shop. (FLIGHT Photo.)

THE ROYAL AIR FORCE

London Gazette, May 19, 1931.
General Duties Branch

The follg. are granted short-service commns. as Pilot Officers on probation with effect from and with seny. of May 6:—M. Hare, A. J. Hicks, E. S. Macpherson, T. H. L. Nicholls, J. Ramsden, G. G. Sharp-Bolster, D. Sloan, S. W. F. Smyth, A. Threapleton, G. F. Wood. The follg. Pilot Officers on probation are confirmed in rank:—J. G. B. O'Hagan (April 11); E. J. N. Heaven (April 25). The follg. Pilot Officers are promoted to rank of Flying Officer:—F. A. McNeill (Jan. 13); G. G. Barrett, F. R. Drew (Jan. 27); D. W. H. Heath (Feb. 28); H. St. G. Burke (with seny. Sept. 27, 1930) (March 27); C. P. F. Alderson, N. D. Lamb, J. F. Sutton (April 11); I. O. Baldwin, N. V. Bertram, F. P. R. Dunworth, N. Foster-Packer, N. Hill, G. W. Lawson, D. E. Milson, F. A. J. Pollock-Gore, W. J. Scott (April 14). Pilot Officer on probation W. R. Ottewill resigns his short-service commn. (May 10); the short-service commn. of Pilot Officer on probation H. W. Riley is terminated on cessation of duty (May 20); Lt. Cdr. A. N. R. Keene, R.N., Flying Officer, R.A.F., relinquishes his temp. commn. on return to Naval duty (April 8); Lt. J. E. Vallance, R.N., Flying Officer, R.A.F., relinquishes his temp. commn. on retirement from the Royal Navy (May 20); Lt. P. Bethell, R.N., Flying Officer, R.A.F., relinquishes his temp. commn.

on return to Naval duty (April 22) (substituted for Gazette, May 5); Gazette, May 12, concerning Wing Commander E. B. Beauman is cancelled.

RESERVE OF AIR FORCE OFFICERS

General Duties Branch

The following are granted commns. in Class AA (ii) as Pilot Officers on probation:—B. G. Horstmann, B. P. Turner (May 4). The following Pilot Officers on probation are confirmed in rank:—E. P. S. Davidson (April 25); A. M. MacLachlan (May 5); R. W. O'Sullivan (May 5). Pilot Officer the Hon. H. C. H. Bathurst, of the Special Reserve, is promoted to rank of Flying Officer (April 26); Flying Officer F. F. Wilkinson is transferred from Class A to Class C (July 3, 1930).

The following Flying Officers relinquish their commns. on completion of service:—F. R. Matthews (Nov. 9, 1930); H. E. Greenberry (March 29); P. A. A. Boss, B. H. Cook, W. E. L. Courtney, J. Craig, H. M. Gibbs, G. A. Milbank, G. Richardson, R. V. Weeks (April 20); P. R. Dawson (May 1). Flying Officer G. H. Winckworth relinquishes his commn. on completion of service, and is permitted to retain his rank (Dec. 8, 1930).

Stores Branch

Flying Officer R. Lamb relinquishes his commn. on completion of service (April 30).

ROYAL AIR FORCE INTELLIGENCE

Appointments.—The following appointments in the Royal Air Force are notified:—

General Duties Branch

Wing Commanders: L. F. Forbes, M.C., to R.A.F. Depot, Uxbridge, on transfer to Home Establt., 26.4.31. H. P. Lale, D.S.O., D.F.C., to H.Q., Inland Area, Stanmore, 11.5.31. H. I. Hamner, D.F.C., No. 503 Sqn., Lincoln, to command, 11.5.31.

Squadron Leader T. W. Elsdon to H.Q., Coastal Area, 12.4.31. **Flight Lieutenants:** L. Young, to R.A.F. Reception Depot, West Drayton, 11.5.31. F. H. E. Reeve, to Station H.Q., Amman, Transjordan, 22.3.31. S. M. Park, to H.Q., Aden Command, 1.4.31. W. J. M. Akerman, to R.A.F. Depot, Uxbridge, 26.3.31. H. A. Evans-Evans, to H.Q., R.A.F., Transjordan and Palestine, 22.3.31. H. S. Sandiford, to No. 5 Flying Training School, Sealand, 11.5.31.

Flying Officers: H. V. L'Amy, to No. 40 Sqn., Upper Heyford, 20.4.31; G. Calvert, E. G. Reed, R. B. Whittingham, all to No. 40 Sqn., Upper Heyford, 5.5.31. G. H. W. Selby-Lowndes, to Central Flying School,

Wittering, 11.5.31. J. Mutch, to Central Flying School, Wittering, 11.5.31. J. N. Jaques, to No. 5 Flying Training School, Sealand, 11.5.31.

Pilot Officers: M. Hare, A. J. Hicks, E. S. Macpherson, T. H. L. Nicholls, J. Ramsden, G. G. Sharp-Bolster, D. Sloan, S. W. F. Smyth, A. Threapleton, G. F. Wood, all to R.A.F. Depot, Uxbridge, on appointment to short service commissions as Pilot Officers on probation, with effect from 6.5.31.

Stores Branch

Flight-Lieutenants: F. J. W. Humphreys, to No. 10 Group H.Q., Lee-on-Solent, 12.5.31. A. H. Comfort, to R.A.F. Base, Gosport, 4.5.31.

Flying Officers: C. H. Baker, M.B.E., to Stores and Supply Depot, Aden, 2.5.31. T. A. Head, to Station H.Q., Kenley, 1.5.31.

Accountant Branch

Flight-Lieutenant P. Hay, M.C., to No. 2 Flying Training School, Digby, 1.5.31.

Medical Branch

Squadron Leader A. J. Brown, D.S.O., to R.A.F. Depot, Uxbridge, 19.4.31.

IN PARLIAMENT

Aviation Accidents.

MR. MONTAGUE, on May 20, in reply to Maj. Glyn, etc., said: The following table gives the aircraft accidents during periods January 1 to May 19:—

| | 1925. | 1927. | 1929. | 1931. |
|-------------------------------------|-------|-------|-------|-------|
| Royal Air Force personnel:— | | | | |
| Killed | 16 | 24 | 16 | 45 |
| Injured | 47 | 39 | 31 | 39 |
| Persons using commercial aircraft:— | | | | |
| Killed | 1 | — | 2 | 1 |
| Injured | — | — | — | 2 |

I should add that in 1931 there has been a very large increase in the amount of flying carried out both by Royal Air Force and civil aircraft as compared with the earlier years. No persons were killed or injured while using machines of British companies operating regular or taxi air-transport services in or originating from this country during any of the above periods. The figures exclude accidents to club or privately owned aircraft.

The original cost of Royal Air Force machines that have been lost this year as a result of accidents both at home and overseas was roughly, £220,000, but the actual value at the date of loss was, of course, very much less; the value of the parts salvaged cannot be estimated without undue labour.

ROYAL AIR FORCE FLYING ACCIDENTS DURING PERIOD JANUARY 1 TO MAY 19, 1931

| | Home. | Abroad. |
|---|-------|---------|
| Aeroplanes crashed and written off charge | 56 | 17 |
| These figures include:— | | |
| New aeroplanes under test | Nil | Nil |
| Aeroplanes of a type over three years old | 47 | 12 |
| Aeroplanes crashed as the result of failure of engine or other material | 6 | 2 |
| Aeroplanes crashed as the result of collision | 8 | Nil |

Full information as to the causes of many of the accidents which resulted in aircraft being written off charge is not at present available, and it is possible that the figures relating to engine and other failure may have to be revised.

R.A.F. and Parachutes

COMMANDER SOUTHBY, on May 20, asked the Under-Secretary of State for Air what is the date of the design of the life-saving parachutes now used in

the Royal Air Force; at what minimum height they are considered to be effective; whether any new or more efficient parachute is under consideration; if so, at what height it is effective; and whether it is intended to supply the new type to the Royal Air Force without delay?

MR. MONTAGUE: I am glad this question has been put, as it enables me to deny emphatically the allegation, which has appeared in a certain newspaper, that the parachutes used by the Royal Air Force are obsolete and are not safe under 800 to 1,000 ft. As regards the first three parts of the question, the parachute now used was originally designed about 1922 and is standard equipment in the air forces of at least 17 countries and is extensively employed in civil aviation. It is difficult to state definitely the minimum height at which it will certainly be effective, as this depends, among other things, on the velocity at which the aircraft itself may be falling; but on two occasions these parachutes have saved life in drops from as low as 150 ft. The Air Ministry is always alive to the possibility of an improved type of parachute, but in its existing form the present standard type is more efficient and effective than any of the other types which have been examined since its introduction. The last two parts of the question do not, therefore, arise.

COMMANDER SOUTHBY: Has the attention of the Under-Secretary been specifically called to the new type of parachute which was recently tried at Brooklands?

MR. MONTAGUE: The statement made in the newspaper to which I have referred is the only one of which I have heard recently, and that was dealt with by the Air Ministry over 18 months ago and turned down. New types are being constantly experimented with and tried.

R.A.F. (Parachutes)

SIR W. BRASS, on May 21, asked the Under-Secretary of State for Air whether his attention has been called to the new British Russell-Lobe parachute which was demonstrated recently at Brooklands; and whether his experts have yet had an opportunity of testing its efficiency under service conditions?

MR. MONTAGUE: I am advised that the Russell-Lobe parachute is, like the Irvin parachute at present standard in the Royal Air Force, an American parachute manufactured under licence in this country. It was tested less than 18 months ago under the same conditions as all other parachutes submitted to the Air Ministry. If any new features have been embodied in its design since then, the makers have not brought the fact to the notice of the Air Ministry or asked that a further test should be conducted in the light of them. The Air Ministry is, of course, at all times ready to investigate the merits of any new design which affords promise of being an advance on the type at present in use. All the alternative types so far tested have been found to suffer from drawbacks of one kind or another which render them definitely inferior to the existing pattern.

Trinidad, Helium

MR. MONTAGUE, in reply to Dr. Morgan, said: It has been suggested, from time to time, that helium might be found in the natural gases from the Trinidad oil fields, but my information is that nothing more than a trace of helium has so far been identified. Further investigations into the possibility of helium being found in quantity are in progress. The Air Ministry is, of course, closely watching developments.

AIRCRAFT COMPANIES' STOCKS AND SHARES

HEAVY forced selling, which only showed signs of relaxing towards the end of the month, has led to a general marking-down of industrial share prices during May. It is not surprising, therefore, that the shares of aircraft and associated companies have again moved against holders; but, had market conditions been less depressed, prices might have made some response to current talk of amalgamations in the industry, although it should be pointed out that rumours of this kind are treated with reserve in responsible quarters. Handley Page participating preference show a decline on balance for the month; last month market rumours of a larger dividend had caused a certain amount of speculative activity in the shares, which subsequently diminished. The increased profits for the past year and the maintenance of the dividend was regarded as an excellent result. The price firmed up after the meeting, where a favourable impression was created by the statement relative to patent rights. De Havilland ordinary have been a feature of strength, and last month's improvement in price has been well maintained. On the basis of the past year's reduced dividend of 5 per cent., the yield is small; but last year over 10½ per cent. was earned on the ordinary shares, and there may be the possibility of a larger dividend for the current year, although the chairman's remarks at the meeting were very cautious, and a conservative dividend policy is expected to be continued. D. Napier & Son's ordinary have gone back about 1s.; they are, nevertheless, above the lowest price touched this year. The 7½ preference shares have marked higher prices on attention drawn to the satisfactory yield and the good cover for the dividend shown by the past year's profits. Imperial Airways, Rolls-Royce and Vickers' ordinary shares have touched the

lowest prices recorded this year, owing to demand being at a low ebb rather than to exceptionally heavy selling pressure. Later prices showed some recovery in sympathy with the better tone of markets generally. The heavy fall in "Shell" and Dunlop Rubber ordinary is due to the "cuts" in the dividends for the past year, and S. Smith & Sons' issues went back on the reduction in the interim dividend on the preferred ordinary shares. The improvement in British Thomson-Houston preference is explained by the probability that the repayment of the company's debenture stock, formal notice of which has been given, will increase the capital value of the preference shares.

PUBLICATIONS RECEIVED

Bibliography of Aeronautics, 1929. U.S. National Advisory Committee for Aeronautics, Washington, D.C., U.S.A. Price 35 cents.

The Motor Electrical Manual. 5th Edition. London: Temple Press, Ltd. Price 2s. 6d. net.

"Missing." By T. B. Bruce. Edinburgh and London: William Blackwood & Sons, Ltd. Price 5s. net.

Vandals of the Void. By J. M. Walsh. London: John Hamilton, Ltd. Price 7s. 6d. net.

Forced Landing. By Berta Ruck. London: Cassell & Co., Ltd. Price 7s. 6d.

Delhi Flying Club Annual Report, 1930. The Delhi Flying Club, Delhi, India.

Handbook of Aeronautics, 1931. Published under the authority of the Royal Aeronautical Society. Aldershot and London: Gale & Polden, Ltd. Price 25s. net.

Chloride Chronicle and Excise News, No. 48. The Chloride Electrical Storage Co., Ltd., Clifton Junction, near Manchester.

NEW COMPANY REGISTERED

THE A.T.S. CO., LTD.—Capital £3,000, in £1 shares. Objects to acquire patents, concessions, licences, etc.; to carry on the business of manufacturers of and dealers in aeroplanes, balloons, airships, flying machines, motors, etc. The subscribers (each with one share) are:—H. N. Wylie, 5 and 6, Clements Inn, W.C.2; consulting engineer. D. H. Emby, Ampney Crucis, Glos, consulting engineer. The Gloster Aircraft Co., Ltd., Sir W. G. Armstrong Whitworth Aircraft, Ltd., and Boulton & Paul, Ltd., may each appoint one director. In the event of any two of the said companies amalgamating, one of the directors appointed by such amalgamating companies shall resign, and the amalgamated company shall have the same rights as to removal of the other director and appointment of his successor. Solicitors: Joynson-Hicks & Co., Lennox House, Norfolk Street, W.C.2.

AERONAUTICAL PATENT SPECIFICATIONS

(Abbreviations: Cyl. = cylinder; i.c. = internal combustion; m. = motors. The numbers in brackets are those under which the Specification will be printed and abridged, etc.)

APPLIED FOR IN 1930

Published May 28, 1931

2667. P. MAIWURM. Aircraft. (347,679.)
2740. ECLIPSE AVIATION CORPORATION. Engine starting mechanism. (347,734.)
2839. GOODYEAR TIRE AND RUBBER CO. Gasproof balloon fabric. (347,735.)
2925. TARBON SAFETY AIRCRAFT CO. Aircraft balancing systems. (347,708.)
4577. CIERVA AUTOGIRO CO., LTD., and LA CIERVA, J. DE. Aircraft having freely rotative wings. (347,779.)
7457. B. BANNERMAN. Diminishing visibility of aircraft. (347,809.)
13,747. ECLIPSE AVIATION CORPORATION. Electrical generating systems. (347,889.)
22,663. ECLIPSE AVIATION CORPORATION. Sparking-plugs. (347,979.)

FLIGHT, The Aircraft Engineer and Airships.

36, GREAT QUEEN STREET, KINGSWAY, W.C.2.

Telephone (2 lines): Holborn, 3211.

Holborn, 1884.

Telegraphic address: Truditur, Westcent, London.

SUBSCRIPTION RATES POST FREE

| UNITED KINGDOM | | UNITED STATES | | OTHER COUNTRIES* | |
|----------------|------|---------------|--------|------------------|------|
| s. d. | | s. d. | | s. d. | |
| 3 Months | 8 3 | 3 Months | \$2.20 | 3 Months | 8 9 |
| 6 " | 16 6 | 6 " | \$4.40 | 6 " | 17 6 |
| 12 " | 33 0 | 12 " | \$8.75 | 12 " | 35 0 |

* Foreign subscriptions must be remitted in British currency.

Cheques and Post Office Orders should be made payable to the Proprietors of "FLIGHT," 36, Great Queen Street, Kingsway, W.C.2, and crossed "Westminster Bank."

Should any difficulty be experienced in procuring "FLIGHT" from local newsvendors, intending readers can obtain each issue direct from the Publishing Office, by forwarding remittance as above.

| Name. | Class. | Nominal Amount of Share. | Last Annual Dividend. | Current Week's Quotation. |
|--|----------------|--------------------------|-----------------------|---------------------------|
| Anglo-American Oil .. | Deb. | Stk. | 5½ | 100½ |
| Armstrong Siddeley Develop. .. | Cum. Pref. | £1 | 6½ | 13/9 |
| Birmingham Aluminium Castg. | Ord. | £1 | 7½ | 19/6 |
| Booth (James), 1915 .. | Ord. | £1 | 15 | 39/- |
| Do. do. .. | Cum. Pref. | £1 | 7 | 22/6 |
| British Aluminium .. | Ord. | £1 | 10 | 24/6 |
| Do. do. .. | Cum. Pref. | £1 | 6 | 19/6 |
| British Celanese .. | Ord. | 10/- | Nil | 4/- |
| British Oxygen .. | Ord. | £1 | 8s | 14/4½ |
| Do. do. .. | Cum. Pref. | £1 | A | 20/4½ |
| British Piston Ring .. | Ord. | £1 | 22½ | 28/9 |
| British Thomson-Houston .. | Cum. Pref. | £1 | 7 | 24/- |
| Brown Brothers .. | Ord. | £1 | 10 | 22/7½ |
| Do. do. .. | Cum. Pref. | £1 | 7½ | 22/7½ |
| Dick (W. B.) .. | Cum. Pref. | £10 | 5 | 120/- |
| De Havilland Aircraft .. | Ord. | £1 | 5 | 21/- |
| Dunlop Rubber .. | Ord. | 6/8 | 6 | 6/9 |
| Do. do. .. | "C" Cum. Pref. | 16/- | 10 | 11/6 |
| En-Tout-Cas (Syston) .. | Def. Ord. | 1/- | Nil | 1/4½ |
| Do. do. .. | Ptg. Pfd. Ord. | 5/- | 8 | 4/5½ |
| Fairey Aviation .. | Ord. | 10/- | 7* | 11/6 |
| Do. do. .. | 1st. Mt. Deb. | Stk. | 8 | 106½ |
| Firth (T) & John Brown .. | Cum. Pref. | £1 | 6 | 9/6 |
| Do. do. .. | Cum. Pref. | £1 | 5* | 12/- |
| Ford Motor (England) .. | Ord. | £1 | 10 | 53/9 |
| Fox (Samuel) .. | Mt. Pfd. Stk. | 5 | 5 | 72½ |
| Goodyear Tyre & Rubber .. | Deb. | Stk. | 6½ | 101½ |
| Handley Page .. | Ptg. Pref. | 8/- | 12½ | 10/- |
| Hoffmann Manufacturing .. | Ord. | £1 | Nil | 18/9 |
| Do. do. .. | Cum. Pref. | £1 | 7½ | 14/9 |
| Imperial Airways .. | Ord. | £1 | 5 | 13/1½ |
| Kayser, Ellison .. | Ord. | £5 | 6 | 60/- |
| Do. do. .. | Cum. Pref. | £5 | 6 | 77/6 |
| Lucas (Joseph) .. | Ord. | £1 | 25 | 62/- |
| Napier (D.), & Son .. | Ord. | 5/- | 15 | 7/- |
| Do. do. .. | Cum. Pref. | £1 | 7½ | 24/7½ |
| Do. do. .. | Pref. | £1 | 8 | 22/4½ |
| National Flying Services .. | Ord. | 2/- | Nil | -/6 |
| Petters .. | Ord. | £1 | 7 | 22/- |
| Do. do. .. | Cum. Pref. | £1 | 7½ | 18/1½ |
| Roe (A. V.) (Cont. by Armstrong Siddeley Devel., q.v.) | Ord. | £1 | — | — |
| Rolls-Royce .. | Ord. | £1 | 10 | 29/9 |
| Smith (S.) & Sons (M.A.) .. | Def. Ord. | 1/- | 18½ | 1/1½ |
| Do. do. .. | Ptg. Pfd. Ord. | £1 | 12½ | 14/- |
| Do. do. .. | Ord. | £1 | 7½ | 16/10½ |
| Serck Radiators .. | Ord. | £1 | 17½ | 34/6 |
| "Shell" Transport & Trading .. | Ord. | £1 | 17½* | 45/7½ |
| Do. do. .. | Cum. Pref. | £10 | 5 | 10/- |
| Triplex Safety Glass .. | Ord. | £1 | 5 | 23/- |
| Vickers .. | Ord. | 6/8 | 8 | 6/6 |
| Do. do. .. | Cum. Pref. | £1 | 5* | 17/7½ |
| Vickers Aviation (Cont. by Vickers, q.v.) | — | — | — | — |
| Westland Aircraft (Branch of Petters, q.v.) | — | — | — | — |
| Whitehall Electric Investm'ts. | Cum. Pref. | — | 7½ | 24/3 |

A Issued in January.

* Dividend paid tax free.

B Rate per annum for nine months.